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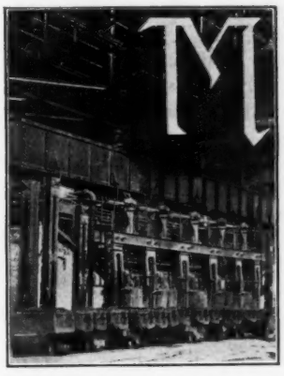
Open-Hearth Steel Furnace Progress

Recent Advances in the Design and Construction of These Melting Mediums for the Steel Foundry

By Herbert F Miller Jr.



MANY recent changes in the design and construction of open-hearth furnaces for making steel for casting purposes have been aimed at economies in fuel consumption. The steadily increasing price of fuel oil presents a serious problem to steel foundrymen, particularly if their plants are not equipped with gas producers, and numerous experiments are being made with tar, which has been used successfully in open-hearth furnaces of large capacity at a number of steel plants. The various fuels adapted to open-hearth operations include producer and natural gas, powdered coal and the liquid fuels such as oil and tar. The construction of open-hearth furnaces varies with the kind of fuel used and to attain the highest efficiency, the design should be such as to insure the complete combustion of the fuel employed.

Combustion of Liquid Fuel

The burning of liquid fuels generally is aided by atomizing with compressed air or steam, thereby creating a forced draft in the furnace which, combined with the incomplete combustion of the fuel, results in unsatisfactory operations. Ample space must be provided to permit of the escape of the waste gases or they will be blown out of the furnace doors, making it practically impossibile to operate such an open-hearth unit where this condition exists. The incomplete combustion of the fuel oil is due to the cold air used for atomizing and forms the medium of combustion in place of the preheated air from the checkers. Therefore, the temperature of the flame will be much lower than if the fuel had been burned with preheated air only.

To insure complete combustion of the fuel and to attain the highest possible flame temperature, the intimate mixture of the preheated air and oil must be effected. Recently the writer was requested to investigate the operation of an open-hearth furnace using oil as fuel, but equipped with ports of the producer gas type. The burners were of the water-cooled type, the ends of which extended well down into the gas ports, but as combustion was imperfect the burners gradually were drawn back. As a result, the combustion of the fuel was improved, but no marked change occurred until the burners were pulled back across the uptake. The flame then was changed to one of intense heat, the bottom of the port was melted and the rings of the arch began to drop. The time of making the heats was reduced two hours as compared with the period required when the burners rested on the ports. The same effect was obtained when oil was used with forced draft in an open port type of furnace. When the burner in a furnace of the latter type was drawn across the uptake, the intense heat generated melted the roof and the bottom of the port. The temperature that can be attained by this arrangement of furnace is sufficiently high to melt magnesite.

Owing to the excellent results obtained it was decided to construct a burner and to arrange a port whereby all of the beneficial effects previously noted could be secured, eliminating the damage to the roof and port from a high temperature generated in the furnace. The type of construction evolved, as a result of these experiments, is illustrated in Figs. 1, 2 and 3. The oil pipe is introduced through either a water-cooled tuyere or a hollow pier. The pipe passes through uptake, *A*, and terminates at a point near the top of uptake *A1*, the fuel being introduced into a layer of preheated air from uptake, *A1*. The fuel strikes a rising current of highly preheated

Herbert F. Miller Jr.

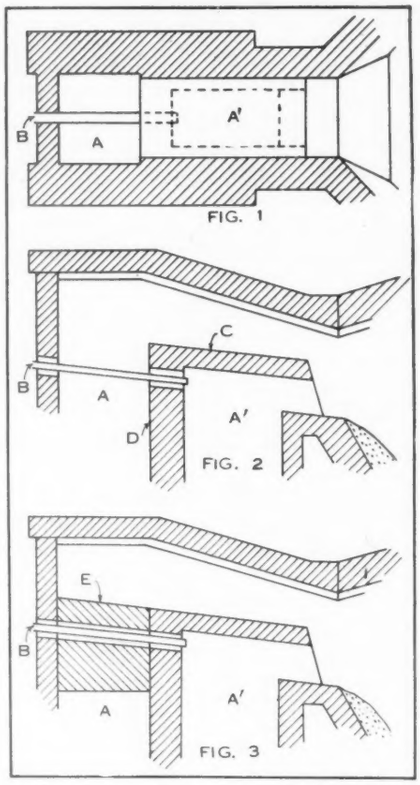
In the operation and design of open-hearth furnaces for the manufacture of both rolled and cast steel, Herbert F. Miller Jr.'s experience, although covering a period of only five years, has been varied and included some exceedingly important work. While at Harvard University he specialized in metallurgy for four years under the direction of Prof. Albert Sauveur and in 1908 he became connected with the Carrie blast furnace department of the Carnegie Steel Co., subsequently having been transferred to the metallurgical department, open-hearth furnaces, etc. In April, 1911, he accepted the position of melting foreman and open-hearth superintendent of the Verona Steel Castings Co., Verona, Pa., and while thus employed he rebuilt and redesigned the open-hearth furnaces of this plant. Recently Mr. Miller was appointed superintendent of the open-hearth department of the Sweet's Steel Co., Williamsport, Pa. Mr. Miller has written extensively on subjects relating to open-hearth furnace construction and operation.

air at right angles, thereby effecting an intimate mixture of the fuel and air, producing a flame of high temperature. The flame enters the melting chamber direct and the heat is absorbed by the bath of metal. As a result of this arrangement the furnace port is not damaged and a protecting layer of air between the roof and the flame is provided. Operating under these conditions the air for atomizing the oil can be introduced at an extremely low pressure. When the burners are in their usual position extending across the uptake, the high pressure at which the fuel and air are introduced oxidizes the metal bath and a refractory coat sometimes is formed which retards melting operations. This can be overcome by using air at a low pressure. Forced draft usually melts the slag checkers rapidly, particularly when the latter are located directly underneath the furnace. In addition, with forced draft, the fuel consumption is high, as the heat units pass out of the furnace rapidly, the temperature of the waste gases being too high when these gases are discharged.

Liquid fuels also may be used efficiently with furnaces of the natural draft type. The fuel is introduced through a perforated, water-cooled pipe and falls down an inclined plane, combustion being effected on top by preheated air from the uptake, *A*, Figs. 12 and 13, and on the bottom by preheated air from the by-pass, *A1*. The flame is similar to that generated by burning natural gas in a furnace of the open port type construction. As the oil is burned by preheated air only and as the furnace is of the natural gas type, this method insures great fuel economy.

Use of Producer Gas

Producer gas for open-hearth furnaces next will be considered. As the majority of these furnaces are not equipped with water-cooled ports, the damage to the brickwork is heavy and the gas consumption is high. The generator chambers particularly are affected by this fuel from the deposition of a tarry substance distilled from the coal. By changing the design of the ports, great economies can be effected, not only by reducing the amount of fuel consumed, but also by largely eliminating the damage to the brickwork. The defects of furnaces of this type are indicated in Fig. 4 in which *C* is the end of the gas port. It will be noted that *C* practically is on the edge of the bath and combustion, therefore, begins to occur at that point, but has no effect until the gas passes a distance of from 5 to 10 feet into the hearth. As the number of heats from the furnace increases the location of *C* gradually moves back as a result of the burning and falling down of the arch. The furnace will reach its highest efficiency when the point, *C*, has been moved back a certain distance, but is still close enough to the bath for the overhead layer of air to hold down the gas on the metal and yet is sufficiently far back to permit combustion to take place at some distance from the bath. Therefore, the temperature at the edge of the port is sufficiently high to melt the steel, but from this time forward the efficiency of the furnace gradually



FIGS. 1, 2 AND 3 — OPEN-HEARTH FURNACE PORTS AS REDESIGNED

decreases. As the point, *C*, continues to move back, the gas is released and discharged from the port at a point where there is practically no overhead layer of air and the result is that the gas floats along the roof with the air mostly underneath it. The lines of draft naturally extend parallel to the furnace, and as the air uptakes are on the sides and the gas port in the center, most of the air naturally will be drawn down along the sides of the furnace and the layer of air will be thinnest over the gas where it is most needed. Therefore, as *C* is moved back gradually, the overhead layer of air becomes thinner until *C* reaches a point where it is in line with the uptake, *A*, and where there is no overhead layer of air. The gas then rises to the roof. The life of a furnace of this type varies from 180 to 250 heats.

The question naturally arises, can a furnace be designed for producer gas which will insure good gas control and good combustion to the end of a run of from 400 to 700 heats? This can be attained by either of two designs, both of which involve the location of a single air uptake directly back of the gas uptake as shown in Figs. 2, 3, 12 and 13. In Figs. 7 and 8 the width of the port is about one-third of that of the hearth. The roof of the port is sharply inclined, compressing the air onto the gas and the roof of the hearth is gradually dropped to meet it. The gas port arch on the other type of furnace is retained, although it is flattened to the width of the port. The end, *C*, Figs. 7 and 8, is at a point from 6 to 10 feet from the edge of the bath. On either side of the port, at *C*, is a small door to permit of making repairs or to effect the removal of brick which might fall from the gas port arch. The point, *C*, will not be moved back as rapidly as in furnaces more generally in use as it is less exposed to the flame than if moved further forward. The probable defect of this design is that when the gas port arch becomes short, combustion will begin too far from the bath, thereby increasing the gas consumption. The further objection is that this design cannot be applied to existing types of furnaces because their ports would have to be lengthened considerably. The question is, if the flame in a furnace of the design outlined always can be controlled, even when a gas port has been burned back to the gas uptake, why should a gas port arch be provided?

Problem Solved

The solution of this problem is indicated in Figs. 5 and 6. It will be noted that this furnace is similar in design to the open port type in use at the Homestead plant of the Carnegie Steel Co. The air uptake is back of the gas uptake from which it is separated by a substantial wall and the gas uptake, which is as wide as the port, is at a point from 6 to 10 feet from the bath. The port is open and smooth, narrow and low. The small cross-section of this port insures a rapid mixture of the preheated air and gas, resulting in a high temperature flame which will be under control throughout the run. It might be presumed that the gas arising at right angles to the air will result in

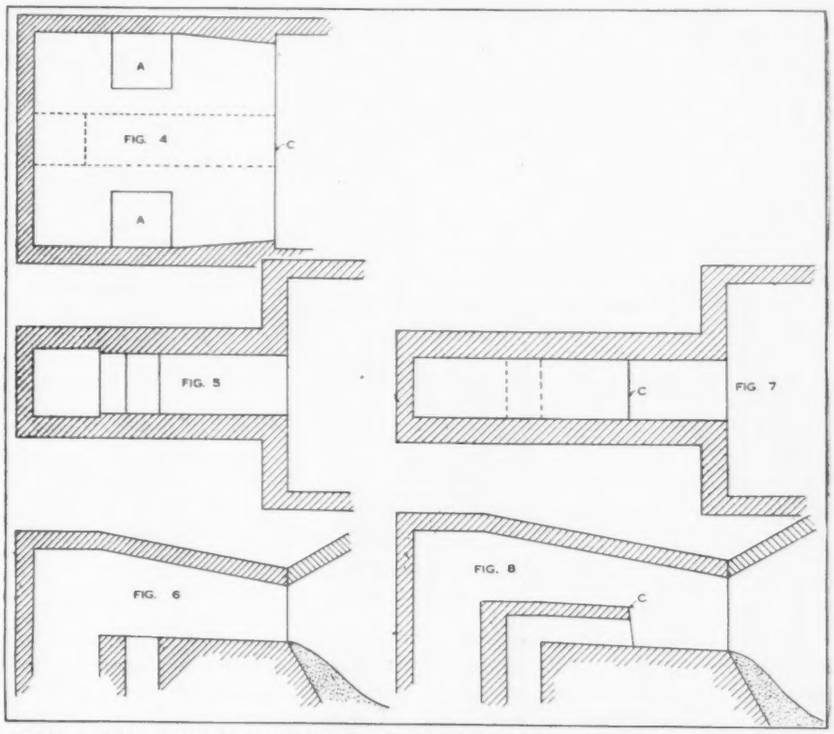
the production of a high flame, but if the port is sufficiently low this will not occur. I have introduced a stream of air at a pressure of 70 feet per square inch underneath the natural gas flame and have found that there was practically no deflection of the flame. This design can be applied to the present type of producer gas furnace, the only alteration of importance involving the reversal of the gas checkers from an outside to an inside position. That great economies could be effected in the number of bricks used in the construction of the ports of a new furnace of this type can readily be appreciated. Repairs to the dividing walls can be made through small seals at the side of the gas port. The flame always will be under control and the furnace should slow up only as a result of dirty checkers and insufficient draft. Natural gas also could be used if desired by introducing it at the sides and in front of the uptake, *C*, Figs. 7 and 8.

Not an Experimental Port

This design of port is not an experiment, but has been successfully used in a Swedish furnace which was operated for 58 weeks without repairs. A furnace of this type is illustrated in Fig. 16. While some experiments have been made in this country with this type of port, they have not proved successful, which can be attributed largely to the fact that the principle was not correctly applied. The chief argument against the use of producer gas as fuel is that one-third of its heat units are lost by combustion in the producer. This, to a large extent, is being overcome by the use of powdered coal which is blown directly into the furnace and is similar to a liquid fuel, being introduced into the furnace in the same manner as the latter. It is claimed that by the use of cold air a temperature may be attained nearly as high as that generated in an electric furnace. From this it would seem that there is no need of the regeneration of the air. However, the waste gases pass off at a high temperature and the fuel cost is high in comparison with that of a furnace using preheated air with powdered coal. It is claimed that more gas is consumed per ton of steel made in a producer gas furnace than in one of the natural gas type. While this is true when based on the tonnage of steel produced, nevertheless it will be admitted that a given size of stack will not draw any more waste gases out of a producer gas furnace per minute than out of a natural gas furnace. Furthermore, with the hearths of the same size and with the space occupied by the flame the same in each type of furnace, two factors are balanced, whereas the temperature of the producer gas flame is hotter than that of the natural gas.

The next and most important factor to consider is the means provided by each furnace for effecting the combustion of their respective fuels. In a natural gas furnace the fuel is in working condition before it reaches the hearth and is ready to impart its heat units to the molten bath and does so until it leaves the furnace. Even with a natural gas furnace, the tendency to chill is apparent unless steps are taken to overcome this trouble. However, in a producer gas furnace the gas is not in condition to do effective work until it has passed some distance from the hearth. Even then, the distance from the overhead source of combustion, the large space in which the air and gas unite, and the comparatively slow draft under which they unite, all have a tendency to produce poor combustion and a lower flame temperature. Unsatisfactory combustion is apparent from the appearance of the gas as it leaves the port and from the fact that the bath freezes under the gas at the sides of the furnace at which the gas enters and the metal has to be melted again when the gas is reversed, thereby compelling this operation to be repeated until the furnace has picked up enough heat in the checkers and the bath has become hot enough to overcome the chilling tendency of the entering gas. These facts indicate that if the producer gas is prepared for its work similar to natural gas a more rapidly melting furnace will be insured, because of the higher temperature that producer gas is capable of producing. However, at the present time, the producer gas furnace is the slower of the two and will remain so until it is designed along more rational lines.

Some objections have been raised against the proposed design of a producer gas furnace, as it is believed that the gas will rise up through the overhead air and burn the roof. A consideration of the design of the furnace, however, will prove this to be untrue. The port has a small cross-section, thereby insuring a tremendous draft. The gas enters from the uptake at a pressure of not over 4 ounces per square inch and the body of air, per cubic foot, is heavier than the producer gas. The gas does not rise at right angles to the bottom of the port because of the powerful draft and is drawn toward the furnace from the face of the port with practically no rising tendency. The gas is struck by an overhead current of heavier air, thereby being depressed still more and will enter the furnace low and will pass out the



FIGS. 4 TO 8—VARIOUS DESIGNS OF OPEN-HEARTH FURNACE FOR THE USE OF PRODUCER GAS AS FUEL

same way. By the time the flame reaches the bath it is in condition to do effective work and the tendency to sulphurize the unmelted steel should be overcome by the same influences.

When natural gas is used in a producer gas furnace it is not subjected to the same treatment as producer gas, as preheated air rises through the gas uptake and the combustion of the natural gas begins where the pipe is introduced into the end of the furnace. If the gas uptake is shut-off, preventing combustion until the gas reaches the bath, then it will be clearly demonstrated that natural gas also must be afforded an opportunity to get into working condition before reaching the bath. If each flame occupies the same position in the furnace and each is given an opportunity to work efficiently, then we should have no more waste with producer

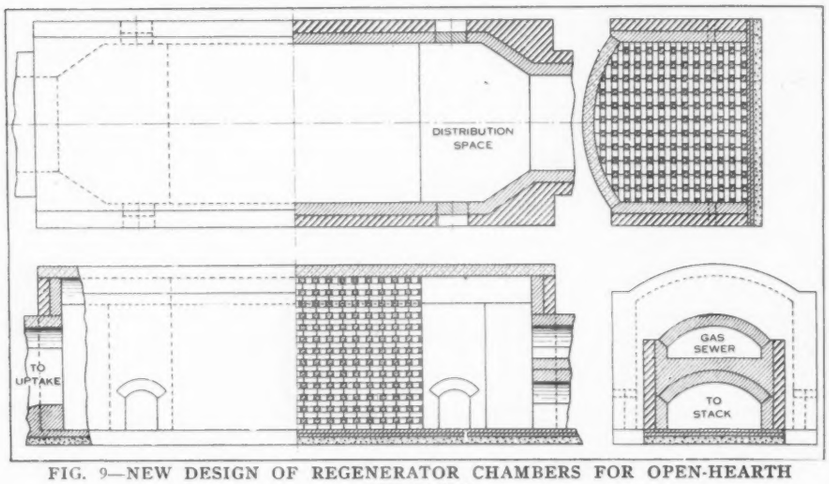


FIG. 9—NEW DESIGN OF REGENERATOR CHAMBERS FOR OPEN-HEARTH FURNACES

than with natural gas, and the waste should be even less. This being the case, there should follow a large reduction in the amount of coal used per heat, or per ton of steel produced.

Some operators object to the use of powdered coal as an open-hearth fuel as it is claimed that the ashes clog the checkers early in the run and that the metal will absorb sulphur. These difficulties can be overcome by changing the construction of the ports, which will insure the satisfactory combustion of the coal before it enters the melting chamber any considerable distance. In the writer's opinion the same type of furnace that is best adapted to liquid fuels should also be used for powdered coal. The construction of a furnace of this type is shown in Figs. 1, 2 and 3.

Natural gas is the ideal fuel for open-hearth furnace operations. It is introduced without preheating and this is the only difficulty surrounding the use of natural gas, as undoubtedly, this fuel would be more effective if it could be preheated. Using the ports, shown in Figs. 12 and 13, with natural gas as fuel will insure an intensely hot flame. The combustion and control of the gas of the Homestead open port type of furnace is influenced almost entirely by the width of the port. If the port is narrow the gas layer increases in depth and acts as an insulator, preventing the bottom gas layer from combining with the overhead layer of air, resulting in poor combustion and a high cost of gas consumption. On the other hand, if the port is increased in width so that the gas layer becomes thinner, combustion is improved, but the control of the gas is lost, which will increase the cost of repairs, due to the burning of the brick. In one steel foundry the lack of flame control was clearly demonstrated. Wide ports were used and combustion was efficient, but the control of the flame was poor. This furnace made only 187 heats and the average time for each heat was 6 hours and 30 minutes on cold charges. As the steel had to be poured at a high temperature it was practically impossible to save the furnace at the end of the heat owing to the poor gas control. During the next run the cross-section of the port was reduced 3½ square feet and this change resulted in a low flame, smoky on the bottom. The time of the heats, however, was increased to 8 hours and 15 minutes. When this smoky flame was noticed the writer concluded that probably the control of the flame might not have to be sacrificed to obtain good combustion if some simple arrangement could be devised suitable to the open port type of furnace. A section of pipe, 4 inches in diameter and about 5 feet long was placed on the port, one end having extended down into the uptake wall and the other end was well down on the port underneath the gas layer. It was believed that the natural draft of the furnace would draw more air through the pipe and would supply the lower gas layer with oxygen. The results surpassed all expectations. The smoky flame was changed immediately to one white in color, but after one reversal, the pipe was melted.

The Principle Evolved

From the experiment outlined, the following principle was evolved: The fuel to be burned efficiently must be introduced into the furnace between the upper and lower layer of preheated air, the upper layer being greater in volume than the lower layer. In Figs. 12 and 13, the preheated air passes up through uptake, *A*, and over the fuel entering at *B*. At the same time some of the air passing through uptake, *A*, is by-passed through passages, *A1*, underneath the gas layer. As a result of this construction, the average time of making heats has been reduced to 4 hours, 2½ hours less than formerly and some heats have been made in 3 hours and 20 minutes, using cold stock and by fast charging. The rapidity with which these heats were made was due to two factors. First, the excellent combustion of the fuel, and second, the almost perfect control of the flame which passed from one port to the other clear of the furnace roof and was projected down into the metal bath. This design can be used with fuels other than natural gas, as the perfect combustion attained does not make it necessary to atomize liquid fuels.

We will now consider the furnace hearth in its special relation to making steel for castings. The manufacturer should know definitely the size of the heats he intends to make continuously and he should have his furnace built for heats of that size. The dimensions of the hearth should not be the same as those of a furnace designed for making ingot steel and the bath should be deeper and should have a smaller surface area. A shallow bath permits slag to pass out soon after the steel commences to flow, preventing the additions from passing into the steel or from becoming uniformly distributed throughout the bath in case they have been hurriedly added. It also is inadvisable to make small heats in hearths of large capacity. If into a 25 or 30-ton furnace

only 12 or 15 tons of metal is charged per heat, the proportion of heats that will be wild or show signs of wildness at some time during the pouring will be comparatively large, whereas when the hearth is charged to capacity a heat showing signs of wildness will be of rare occurrence.

Regenerator chambers for open-hearth furnaces next will be considered. These may be divided into three classes as follows: First, those located directly underneath the furnace; second, those underneath the platform through which the waste gases pass, and third, regenerators underneath the platform having their cross-section filled with checker brick as illustrated in Figs. 9, 10 and 11. The primary cause of the deterioration of an open-hearth furnace as its length of service increases, is the melting-down or rather the slagging of the checker brick, together with the deposition of dirt in the form of iron oxide, etc., which closes the openings. Any construction that will eliminate the necessity of having the waste gases pass down through the checkers will remove the primary cause of the deterioration of the checker work.

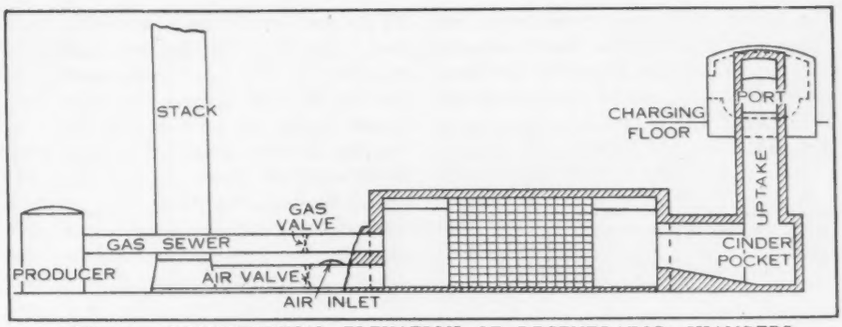


FIG. 11 — LONGITUDINAL ELEVATION OF REGENERATOR CHAMBERS OF NEW DESIGN

Some Defects

Some of the defects of the present types of regenerator chambers follow:

The chambers cannot be cleaned while the furnace is in operation nor can they be cleaned at the end of the run without removing all of the checker brick. This results in a high cost for labor and brick, the labor cost being high because all of the checker brick have to be handled twice. The material cost is high because many of the brick are spalled in double handling, rendering them useless for this service.

The top courses of brick become coated with iron oxide, etc., melt down and considerable dirt is deposited throughout the checkers, particularly on those located at the bottom. The draft of the furnace is decreased by closing the top and bottom openings and the entire operation of the furnace is affected. If an effort is made to clean the checkers, the dirt and brick fall down into the openings, still further reducing the draft.

The distribution of the air and waste gases through the checkers, in many cases is not uniform, resulting in a lower temperature of preheated air and, therefore, a slower working furnace.

These items all are of importance in decreasing the possible tonnage of a furnace.

In the ideal regenerator chamber the checker work, at all times, must be accessible so that the chamber can either be cleaned or repaired while the furnace is in operation. The chamber also must be of such a design that the checkers may be cleaned without removing any of the bricks. The checker work should be so placed as to insure a uniform distribution of air or waste gases and a minimum deposit of dirt on the brick nearest the hearth. Furthermore, the bricks of the chamber should always be in such condition that their removal should not be necessary at any time.

The Ideal Regenerator Chamber

These qualifications the writer believes would be fulfilled by building a regenerator chamber as indicated in Fig. 9. This chamber forms an enlarged portion of the flue proper, the travel from the downtake to the chimney being almost in a straight line. The checkers are built on the floor, thereby eliminating unstable tiles and rider walls. The checkers occupy the central portion of the chamber, with an air space at either end as wide as the chamber for a few feet, then converging at an easy angle to the passageway at each end of the chamber. The air space is an important factor affecting the life of the checkers. The waste gases passing out are slowed-up when they reach this wide distribution area and the suspended dust is deposited on the floor from which it may be removed at any time through the seals at either side of the distribution space at both ends of the chamber. The waste gases then pass through the chamber and deposit only a small amount of dust. After the last heat is off at the end of the week, the gas may be put on the end that is to be cleaned and in a short time the temperature of the end of the chamber nearest the air valve will be sufficiently low to permit a man to enter and clean the checkers with compressed air or steam. The gas checkers are similarly cleaned except that the gas is not admitted and the manhole is opened to supply air. In checkers of this design the gas sewer is entirely separate from the flue to

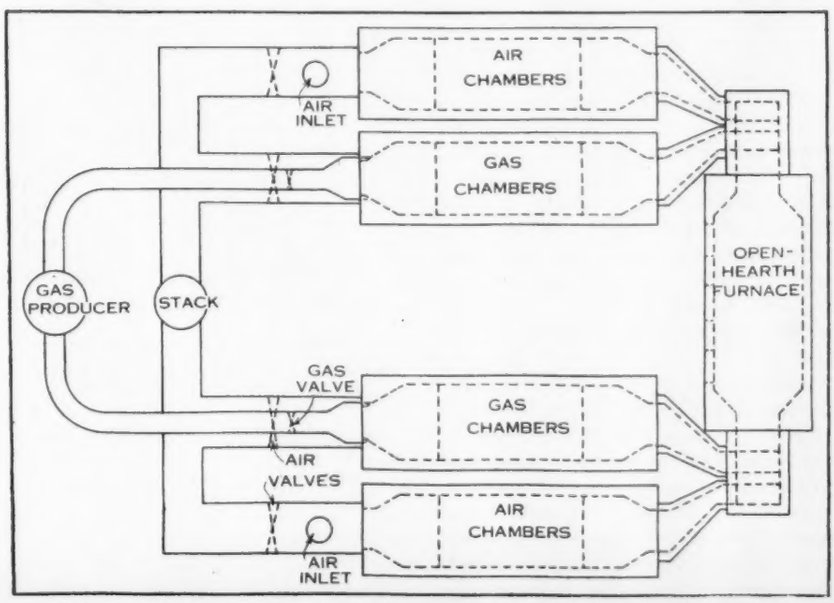
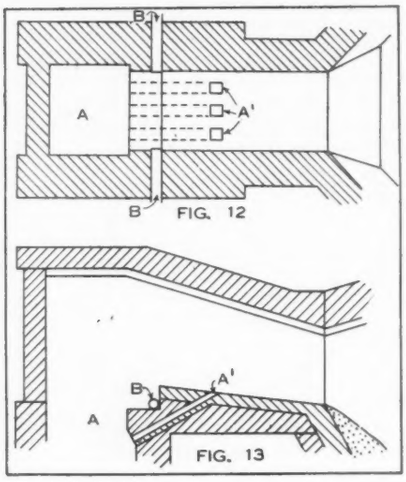


FIG. 10—PLAN SHOWING REGENERATOR CHAMBERS OF NEW DESIGN

the stack and is accessible at all times. In addition, the sewer may be burned out quickly with hot air, using compressed air as an aspirator and by closing the stack chamber from the gas checkers. Under these conditions the checkers will last indefi-



FIGS. 12 AND 13—METHOD OF USING LIQUID FUEL IN A NATURAL DRAFT OPEN-HEARTH FURNACE

nitely with comparatively few renewals of brick and no renewals of the entire checkers at the end of the run. The wet slag as usual, however, will be deposited in the cinder pockets.

Results Obtained

The results obtained with regenerator chambers built according to this design follow:

First.—There will be no slowing-up of the furnace due to the loss of draft because of dirty checkers.

Second.—The draft will be greater because the lines of draft will be straighter. This is important in producer gas work where the travel of the gas should be made as easy as possible. The preheated air or gas will be hotter than with the usual checkers because it will be more uniformly distributed throughout the checkers.

Third.—The tonnage will be increased, the furnace will have a longer run and faster time will be made in producing the steel.

The construction of the tap hole and the spout is another feature that merits consideration in furnace construction. The tap hole should be kept large and low, as the more quickly the steel flows into the ladle the more heat is retained. For the same reason a short spout is desirable. Moreover, a large tap hole will not clog as easily if rabbling has to be done and few *hard* taps will occur. Magnesite is the best material that can be used for closing the tap hole because it will not amalgamate by burning, making a *hard* tap, nor does it boil out as may be the case when the tap hole is closed with green dolomite. Burnt dolomite, however, may be used safely, the only drawback being an occasional *hard* tap due to the material burning the bottom. These facts probably are known to most melters, but constant vigilance is the keynote of success. It may be possible that the bottom is low and the tap hole satisfactory, but if the spout is not smooth at the end it may cause the stream of metal to spread over the ladle, thereby losing much heat and causing a skull. This may result in misrun castings, which might have been avoided if the spout had been properly made. The foregoing discussion of the construction of open-hearth furnaces applies equally to those of the basic and the acid type.

Nature of the Slag

The nature and action of the slag is an important factor in the production of quiet steel. Slags usually are classified roughly by melters according to their physical appearance, as follows:

First.—The dry, heavy slag occurring when there is very little silica present. This is a dangerous slag if not carefully worked. The burning of many furnaces is due to the reflection of the heat to the roof by this slag. Furthermore, the melter, deceived by the physical appearance of the slag, may add an excessive amount of fluorspar. This usually results in a badly cut ladle and the burning-off of the stopper rod. These difficulties can be prevented by the gradual addition of fluorspar until a wet slag is formed, after which the heat may be worked down as usual. When using natural gas for fuel, the heat will foam for some time.

Second.—A wet or lumpy slag insures satisfactory operations. The lumps of limestone should be broken with a rod so that a rocky bottom may be avoided. In some cases a large lump will choke the tap hole and the flow of slag being stopped, the steel is left uncovered until the tap hole can be freed. Therefore, the steel loses a large amount of heat. A lumpy slag may be avoided by adding limestone of small size.

Third.—A waterway slag usually occurs when heats melt high in carbon as a result of the presence of an excess amount of silica. To this slag should be added burnt limestone, burnt dolomite or raw limestone until a thick slag is made. When the slag is too thin, it will mix with the steel when tapped and wild steel will be the result. The ladle and stopper rod will be badly scorified and usually several tons of steel will be discharged into the pit as a result of a burnt-off stopper rod.

Ideal Slag

Ideal slag is heavy and wet and contains no large lumps. This slag makes an easy heat to work and gives the steel a lower phosphorus and sulphur content. Only a small amount of fluorspar is required to put this slag in shape for the ladle. A slag of this kind will not mix with the steel and generally will remain in the furnace until nearly all of the steel has been tapped into the ladle. Furthermore, a heavy slag will not cut the stopper rod nor the ladle brick. The only objection to its use is that it causes a dirty bottom and unless a *washout* is made after each heat, the bottom will rise to the sill plate level after a few heats. This indicates poor practice, as no time ultimately is gained by charging without the usual *washout*. If a *washout* requiring from 20 to 30 minutes is made after each heat, the furnace will have a longer run than otherwise. Furthermore, the holes that occur in a high bottom, to a large extent, will be avoided if the bottom is kept low and clean.

Alloys may be added in the bath or in the ladle. If they are added in the bath, much of the heat of the steel is retained. Adding alloys to the bath while the furnace is working cold or a heat has melted low, is desirable, particularly if some difficulty

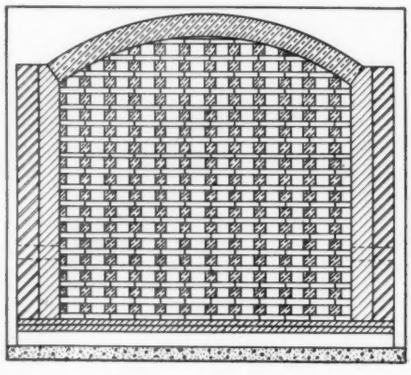


FIG. 14—METHOD OF LAYING CHECKERWORK TO INCREASE THE PERCENTAGE OF AIR PASSAGES

is experienced in getting the metal hot. The additions are made while the flame is still on the bath and the loss of the heat in the bath caused by dissolving the alloys can be retained.

The objections to adding the alloys to the bath are that a larger amount

of each alloy must be added than in the ladle, since from 15 to 30 per cent is carried off with the slag and, furthermore, the silicon, reacting, will throw the phosphorus back into the steel.

If the alloys are added to the metal in the ladle, they first should be heated to redness and they should be shoveled into the metal gradually.

After the heat has melted-down and the limestone has boiled-up, the charge will be benefited by permitting it to soak from 15 to 30 minutes, enabling the contained slag and also a large portion of the gases to rise to the surface. Ore may be added, if necessary, and after it has done its work, or after all of the limestone has boiled-up, the heat should be soaked about an hour or more before tapping to permit the occluded gases to escape. It is my opinion that brittle steel is caused not only by phosphorus, but also by the gases in the steel. I have found frequently that steel low in phosphorus is brittle and on the other hand, steel of a like analysis, after soaking for an hour or more, will be tough.

The carbon should be caught *coming down* rather than by recarbonizing in the ladle, as there is danger of forming gases which will cause wild steel. This will be found particularly true if anthracite coal is used for

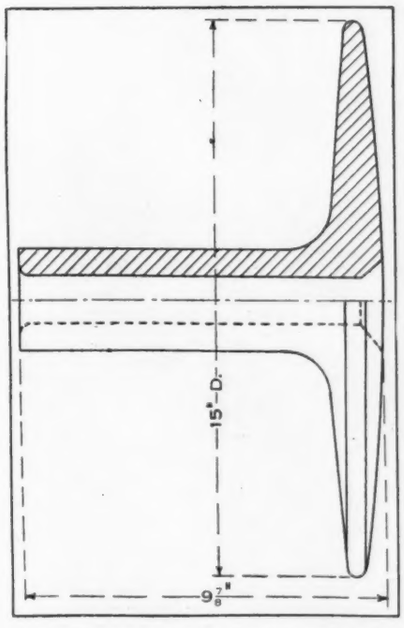


FIG. 15—STEEL CASTING, MUSHROOM IN FORM

recarburizing. Occasionally, if the heat melts low, it is necessary to add carbon to the steel, but I have found that it is advisable to recarburize with carbon of the same nature as that in the steel, namely, powdered petroleum coke, lampblack, etc. When carbon of this kind is used, the steel rarely shows wildness.

Occasionally, heats will melt low and if only small ladles are at hand, or if no heavy castings can be poured, ferro-manganese should be used. This will not add much metal to the bath and serves as a good substitute for pig iron. In plants using large ladles, I recommend working the heats with both pig iron and ferro-manganese. Very little, if any, ferro-silicon should be used in place of ferro-manganese, as the silicon mixes with the slag and cuts off the stopper rod while the heat is being poured. Hot metal is preferable to cold additions, to prevent the chilling of the bath.

The great danger in work *stickers* is in the treatment of slag, which often looks thick and heavy by reason of a cold bath. The mistake constantly is made of adding too much fluorspar. The result is that when the bath begins to pick-up heat, *the slag turns to water*. If the charge is tapped with the steel in this condition and it requires more than 30 minutes to pour the heat, the steel remaining in the ladle will be lost, as the stopper rod will be burnt off and the ladle will be badly cut. On the other hand, if the slag is watery and an attempt is made to thicken it, considerable heat will be lost and much time will be consumed before the metal is ready to tap. This suggests the rule, "Add fluorspar sparingly."

A Curative

If the slag comes too quickly and all of the additions have to be made to the first part of the heat, a uniform distribution of the additions can be readily obtained by rabbling the heat. If some of the additions are lost in the slag, or if an insufficient amount have been added, with the heat showing signs of wildness, a simple remedy is to take a number of sticks of aluminum, bend a tap rod around them, thrust them to the bottom of the ladle, stir the bath with them and rabble afterwards, if necessary. There is hardly a heat that cannot be made absolutely quiet by this means. Unfortunately, it is a curative treatment and a good preventive always is better.

Spongy castings not always are due to wild steel, but may be caused by the method of molding. For example, a casting of mushroom form, Fig. 15, was molded with the stem down, a riser being taken off from one side. When the stem was machined, it was found to be full of blow-holes. At first it was believed that this was caused by the wildness of the metal, but the same result was obtained when the mold was poured with quiet steel. A riser was added to the top of the head and a horn gate was used to feed the steel into the mold. Although this helped, the stem still

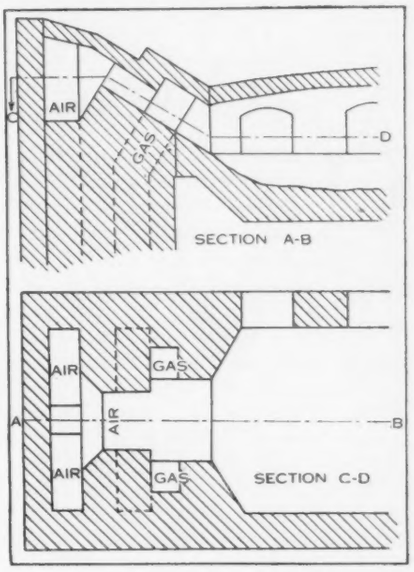


FIG. 16 — HOW A SWEDISH OPEN-HEARTH FURNACE PORT IS DESIGNED

came spongy. Subsequently, the stem was made in a dry sand core and the blow-holes were decreased, but it was not until the casting was made with the stem up and with the head on the stem that the latter came solid. The trouble was caused by the steel preventing the escape of the air when the pattern was molded with the stem down. Therefore, it is apparent that provision always should be made to permit the air to escape from the mold ahead of the steel.

The time consumed in pouring a heat is a factor in determining its size. Good practice demands that a heat of steel should be poured in less than 60 minutes and the faster, the better. If a longer period is required, a reaction occurs between the steel and the slag and this causes

First.—A loss of silicon and a gain of phosphorus and sulphur in the steel.

Second.—The exhibition of wildness in the steel.

Third.—The skulling of the ladle.

Fourth.—Misrun castings.

Fifth.—High ladle cost due to the cutting of the brick by the slag.

Sixth.—The overheating of the stopper rod, the bending of which causes the loss of the remaining steel.

The increased temperature of the steel required when from one to two hours are consumed in casting causes an increase in the occluded gases and requires an increase of 30 per cent in

ferro-silicon to quiet the steel to the same point as when poured at a lower temperature. The use of fluorspar also seems to make the steel less responsive to the quieting action of silicon since the fluorine seems to be absorbed by the steel. I have noticed that after a large amount of fluorspar has been used, a smoky gas is emitted from the steel, which is of the same appearance as the gas which arises when fluorspar is added to the bath. If this is true, the action of fluorspar cannot be beneficial to steel when added in large quantities. Good basic steel is more difficult to make than good acid steel, but if the foregoing suggestions are followed, basic steel, as quiet while molten and as sound when cast as open-hearth steel, will be produced.

How an Intricate Casting Was Made

ALMOST every type of casting, whether large or small, simple or intricate, falls within that all-inclusive term *jobbing work* and many shops engaged in this line of manufacture boast that there is no pattern which they will turn away if the price is satisfactory. As a result, jobbing foundrymen frequently are compelled to exercise considerable ingenuity in the production of complicated and unusual castings. The pattern for a cast iron cylinder with two spiral webs is illustrated in Fig. 1. The work was done at the shop of the Hudson Foundry Co., operated by Lewis Bros., Jersey City, N. J.

As originally delivered to the foundry, the pattern was designed evidently to produce the interior of the mold by screwing out the spiral web portion shown at the right, Fig. 1. This method, however, was found to be impracticable, as no means were provided for adequately supporting the sand between the spaces of the webs. It was concluded, therefore, to make the interior of the mold of dry sand and a core consisting of six parts was produced. This core partly assembled is shown in Fig. 2. The four half circular sections which constitute the top and bottom were made by ramming the sand against the webs of the pattern. After these four sections were dried in the core oven, they were again set in place on the pattern and the quarter circular sections were then rammed and dried, after which the mold was assembled. The drag was rammed on the floor and the mold proper consisted merely of cope and cheek. After the outer portion of the pattern, shown at the left, Fig. 1, had been placed on the floor, it was rammed in green sand, a cheek plate having been employed to support the sand. After ramming the interior of the pattern, the cope was rammed on top of the cheek. The green sand constituting the interior of the pattern then was removed and the dry sand core was set in position,

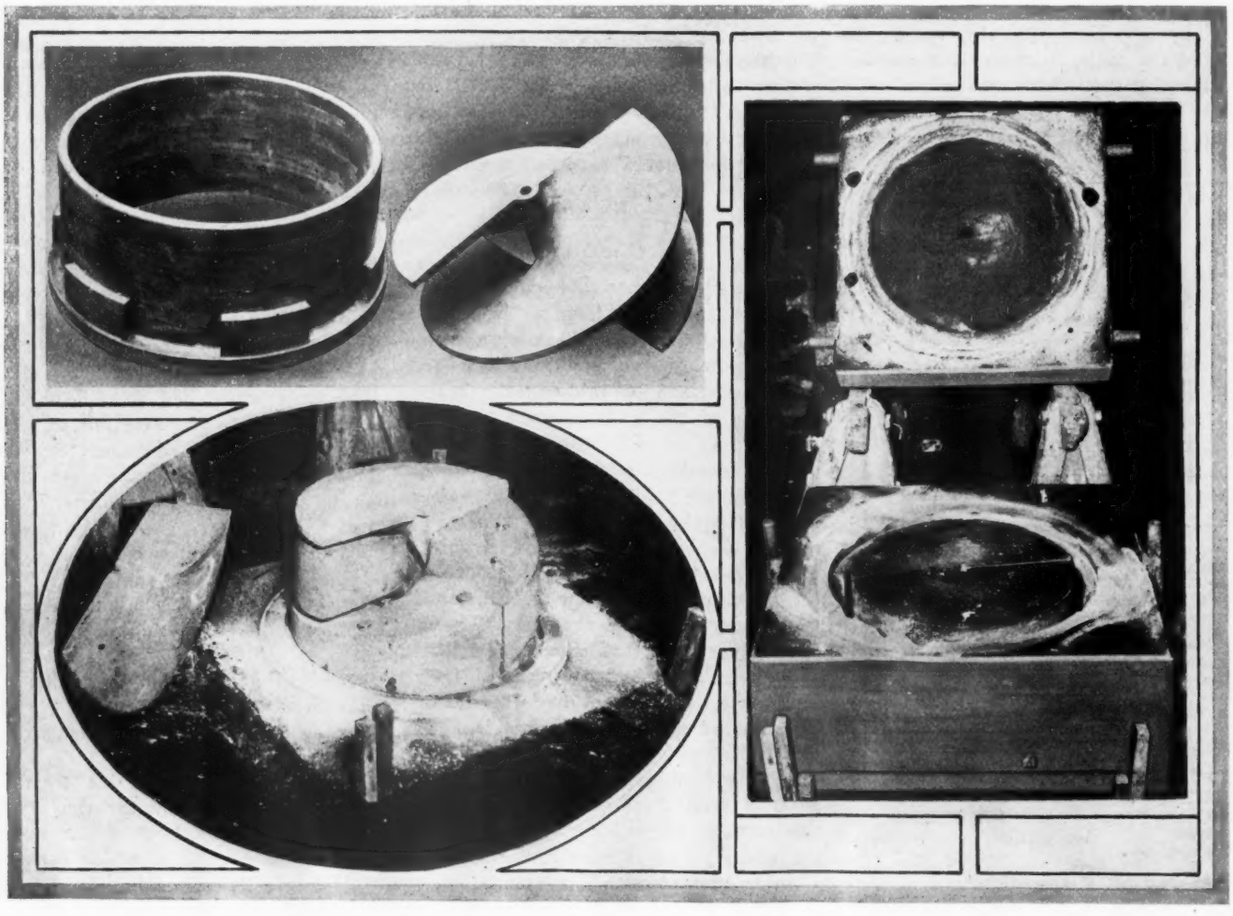


FIG. 1—PATTERN FOR CAST IRON CYLINDER HAVING TWO SPIRAL WEBS

FIG. 2—BUILDING-UP DRY SAND CORE FOR SPIRAL WEB PORTION OF MOLD

FIG. 3—THE SPIRAL WEB MOLD JUST BEFORE CLOSING

as noted in Fig. 2, chaplets having been employed to support the various sections. The mold then was closed, the metal entering through three gates.

Frequency of an Electric Power Circuit

Managers and superintendents who have had to deal with electric power in the operation of the plants under their charge are often puzzled by the question of cycles or frequency. Engineers or the salesmen of electrical companies make certain recommendations on the subject which are usually followed, but in many cases without any clear comprehension of what these terms mean. They are, however, easily explained, and both relate wholly to alternating current machinery.

In a synchronous generator, which is the almost universal type, the current has one-half of a wave or an alternation for each pole passed by a given armature conductor. A cycle is two alternations, forming the complete wave. Frequency is the number of cycles per second. As there is one cycle for each pair of poles passed, the frequency is, therefore, equal to half the number of poles in the generator multiplied by the revolutions made by the armature in each second.

Thus, to deliver current with the common frequency of 60 cycles per second, equivalent to 7,200 alternations per minute, a 2-pole alternator would have to be driven at 60 revolutions per second, or 3,600 revolutions per minute, a 4-pole machine at 1,900 revolutions per minute, etc., which is actually the case with the high speeds made possible in the design of generators direct-connected to steam turbines.

Engine or water-wheel driven generators are made multipolar, and usually with many poles, to avoid speeds which for such units would transcend the limits of safety.

The transformer, by means of which alternating current transmitted at high voltage can be stepped-down to any operating potential desired, has been one of the principal factors in bringing about the general use of that system; and the higher the frequency—other things being equal—the greater is the efficiency of a transformer. Hence, when alternating current was used mainly for lighting circuits, frequencies as high as 140 cycles per second were not uncommon. Motors, however, have been found to operate to the best advantage at frequencies as low as 25 cycles; but, with a lighting circuit added, up to 50 or 60 cycles is desirable. Accordingly, those three frequencies, with others intermediate occasionally used, have come to be accepted as standard. For circuits taking their power from steam turbine units, 25 cycles is practically the minimum, owing to the high speeds of turbo-generators; and this may also be regarded as the lowest limit for a load consisting wholly or partially of lights, as below that frequency incandescent lamps will flicker. On the power side, the series alternating current motor, whose economy rises as the frequency decreases, is the only apparatus for which less than 25 cycles would be required.

Use and Abuse of Slip Jackets

By W H Parry

IN THE hustle and bustle incident to the rapid production of castings in snap molds, it frequently occurs that many of the castings are lost, not because of any fault of the iron or of carelessness in the making of the molds, but as a result of the improper use of slip jackets and weights after the molds are made. In many foundries snap flasks of the tapered side and end variety are in use today and if properly handled are an improvement over the old type. The latter were not adapted to the successful use of *slip-overs,* as slip jackets are sometimes called in the section of the country with which I am most familiar. It would seem that any snap mold with its sides and ends tapered would be ideal for the use of a slip-over, and it is, provided that the slip jacket is merely placed over the mold. However, if any effort is made to force it onto the mold, a defective casting is liable to result. This is particularly true if the angle of a slip jacket differs from that of a flask to the extent that the cope half of the mold is engaged by the slip-over before it touches the drag half. This usually causes a reduction in the thickness of the castings wherever this drawing-down action affects the mold, and is a more prolific cause of bad castings than dirty iron, bad venting or slipshod molding methods.

How Trouble Was Overcome

For many years we experienced considerable trouble in making castings in snap flask molds owing to their reduced thickness at the top as compared with the pattern. Most of the castings thus affected were similar to an inverted bowl in shape, but the thickness of the sides was true to pattern. However, as these castings were not subjected to as high a pressure as they are at the present time, we made no effort to remedy this trouble. Today these castings are subjected to pressures varying from 200 to 500 pounds per square inch and we made a careful investigation to ascertain why the castings were coming thinner at the top than the pattern. We found that the slip-overs were at fault, and greater attention now is being paid to the construction of the tapered snap flask and the slip jackets. The latter are made of gray iron, the corners being riveted when the jackets are in position on a form with angles conforming accurately to the angles of the snap flasks. Our previous difficulty has disappeared entirely. Wooden slip jackets are no longer used.

The Use of Weights

In using weights on snap molds, there are a few points to remember if a foundryman really desires to turn out first class work, and in making a number of suggestions we do not lay claim to the ability of a Sherlock Holmes nor to the possession of a greater knowledge than is possessed by the average foundryman. As a rule, weights receive little attention and the foundryman rarely investigates to ascertain whether both sides of a weight have true surfaces. This permits of using either side of a weight in contact with the mold, although we favor a weight having the mold side scored with V grooves at right angles to each other to prevent clogging the vent openings and provided with pouring holes in such a way, that regardless of where the sprue is cut in the mold, there will be an opening in the weight to match it. It is apparent that a weight machined on the mold contact side and unfinished on the other side is much more durable than one with both sides machined.

The next point to consider is the condition of the cope flask and the straight edge employed to strike off the surplus sand if bench molding, or the condition of the ramming black if a squeezer is used. Unless the surface of the sand upon which the weight is to rest is true, the benefits to be derived from the use of a weight

with a true surface will be nullified. If the sand surface is convex, the weight will rest on the center of the mold only, and it is liable to bear down that section, particularly if there is no support at that point on the joint of the cope and drag.

It is poor practice to arrange too many patterns on a plate, gate or frame in such a manner that the support for the weights is too light. The pattern should be so arranged that a good thickness of sand is left at the joint on all four sides of the mold, even at a sacrifice in the output, as it is apparent that it is more economical to have a reduced output of good castings than a large output of defective castings. In conclusion, the question often arises whether in many instances it would not have been better to have made a casting in a flask rather than in a snap mold, so that when the cope was struck-off, the weight would have rested on the edges of the flask and not directly on the sand.

Stripping-Plate Machines for Pipe Fittings

FOR molding cast iron soil pipe fittings stripping - plate machines are now employed at the plant of Abendroth Bros., Port Chester, N. Y. Prior to the installation of molding machines in this shop, split patterns mounted on wood follow-boards were employed. The core first was made, followed by the cope and the drag, after which the pattern was drawn and the mold was closed. The labor cost of producing soil pipe castings in this way was high and furthermore, the losses were heavy. By the use of stripping-plate molding machines the roll-over operation is eliminated and the production is materially increased. The cope, drag and core all are made separately and are assembled into a complete mold on the floor. In the production of some of the fittings the machines are operated in pairs, one for making the drag and the other for the cope.

In Fig. 3 is shown a pair of machines equipped to produce an extra heavy T-Y casting. Cope and drag halves of this mold with the core in place just before closing are illustrated in Fig. 2. However, to a large extent, specially designed cast iron flasks are employed for most of this work, five different types being shown in Fig. 4. By the use of these flasks, the amount of sand required for each mold is reduced to the minimum and the Y in the foreground at the right is constructed so as to center the core accurately without further adjustment. The stripping-plates are interchangeable and can be mounted on any stripping-plate machine employed for this work. Snap flasks, to some extent, still are used, although these are being rapidly replaced by special cast iron flasks.

The green sand cores are rammed in cast iron, hinged core boxes, one of these being shown in Fig. 1. When

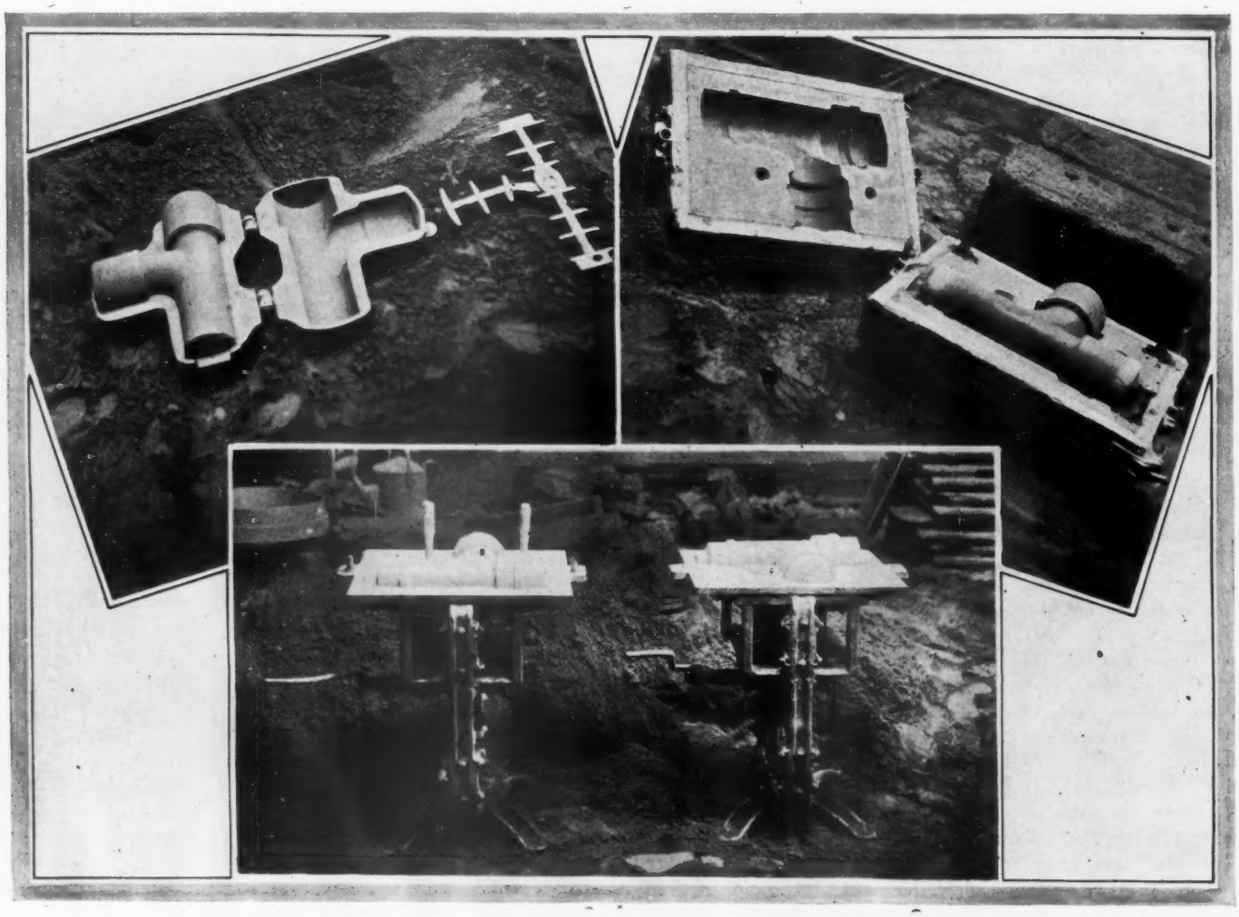


FIG. 1—HINGED CAST IRON CORE BOX AND ARBOR

FIG. 2—MOLD MADE ON STRIPPING-PLATE MACHINE JUST BEFORE CLOSING

FIG. 3—STRIPPING-PLATE MACHINE EQUIPPED WITH PATTERN FOR MAKING A 4 x 4-INCH, T-Y FITTING

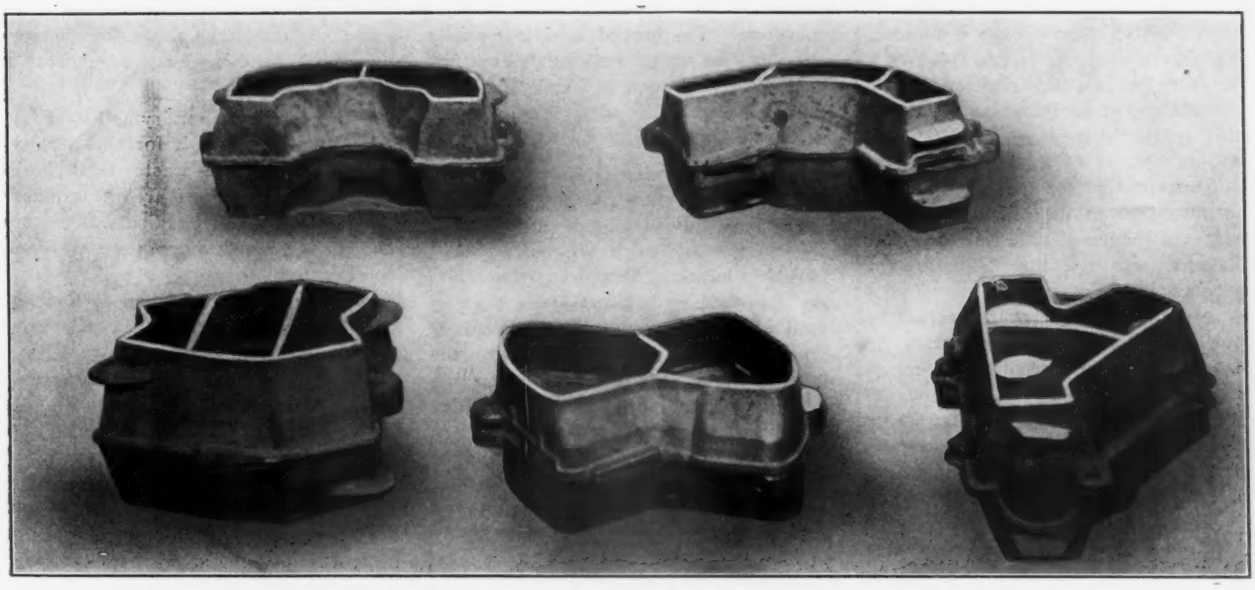


FIG. 4—SPECIAL CAST IRON FLASKS USED FOR MOLDING CAST IRON FITTINGS

making these cores the arbor is clay-washed and is set into the drag side of the box, which is provided with lugs so distributed as to accurately center and support the arbor. After ramming, the core is lifted out of the core box and is set into the drag made on the stripping-plate machine. By the adoption of this method of making soil pipe fittings, Abendroth Bros. have reduced the cost of manufacturing approximately 30 per cent. In addition, the losses are much lower than heretofore and the castings are more uniform in weight and thickness. Floor space also is economized. J. W. Fagan, general manager of the Abendroth Bros. plant, formerly was with the Detroit Stove Works, Detroit, and Robert Walker, foundry superintendent was president of the Associated Foundry Foremen.

The Utilization of Old Foundry Sand

By H Cole Estep

A FOUNDRYMAN was discussing the high cost of making castings with a friend. "It's getting more strenuous all the time," he explained. "Our expenses never get any less and competition is cutting the life out of our selling prices. Here's a fair sample of what we're up against," and he reached for a statement on his desk; "over $300 for sand and in a little while we'll have the pleasure of buying another batch. It's good sand and worth the money, but I wish we could get something back for it after we are through with it. As it is, we use it on the floor as long as possible, then screen some of it for our core mixtures and finally pay the railroad to haul it away. Quite frequently they don't come after it because they have no cars. Then it accumulates in the flask yard and has to be rehandled. Altogether it's a hard problem."

"Did you ever try selling it?" asked the friend.

"Holy smoke! No! Who would want it?" exclaimed the foundryman.

"I have heard of shop owners who sell old sand for real money," was the answer. The foregoing led to an investigation and a large number of letters were mailed to representative foundries in the United States asking for information in regard to their methods of utilizing burnt foundry sand. Although the replies bore out the statement that there are foundrymen who get real money for their old sand, they also indicate that the proportion of shops obtaining any direct return in cash is pitifully small. The statistics that have been compiled indicate that less than 8 per cent, 7.9 per cent to be exact, of the foundries in the United States sell their old sand on a profitable basis for cash. About 26.5 per cent more use it for filling or road-making and thus get an indirect return from it. A few others, 13.2 per cent, use a large proportion of their old molding sand in their core sand mixtures. Over half of the foundries in the country apparently get nothing back at all for their waste sand either directly or indirectly, and in addition over 26 per cent are paying out money to dispose of this material. The foregoing figures are sufficient to indicate the widespread interest in this subject. Although many different methods of reclaiming foundry sand have been suggested, only a few have proved to be of any practical value and some of these cannot be applied except in particular localities. One of the chief difficulties has been that up to the present time new molding sand in the United States is so cheap that foundrymen can afford to spend only limited amounts on reclaiming their old sand.

In some sections a cash market for old foundry sand has been found in the fertilizer industry, other shops have reduced their sand bills by using large proportions of molding sand in their core mixtures, a good many have profitably filled vacant lots with this waste material while others have used it for road making.

Fertilizer manufacturers in some of the larger states in the middle west are paying up to 75 cents per ton at the shop door for old molding sand. It cannot, however, be profitably hauled any great distance, and, therefore, plants that are not located in the vicinity of fertilizer factories cannot take advantage of this opportunity. Not all fertilizer makers use foundry sand, and some use much larger quantities than

others. Also, some buy continuously and others only at certain seasons of the year. As a rule, fertilizer factories will not accept anything but clean sand and refuse containing cores, bricks, gaggers, etc., is of little value.

Comparatively few foundries are taking advantage of the possibility of utilizing old molding sand in their core mixtures, although this is a practical economy which every shop could adopt to advantage. A certain amount of equipment is, of course, necessary. A cheap method of separating the old molding sand from bricks, nails and other foreign material, including spilled iron, is to run it through a common circular rattler with holes about ⅜ inch in diameter punched in the staves. A screen or large riddle mechanically operated, having about a ⅛-inch mesh is also necessary to further clean the sand which comes from the rattler. The proportions in which old molding sand may be used in core mixtures vary widely and range from 20 to 70 per cent. A successful as well as a cheap mixture has the following composition:

60 parts screened, old molding sand.
20 parts new molding sand.
20 parts silica sand.
1 part glutrin.

Sand as a Fill

Old foundry sand is a good material for filling because of the fact that it packs quite hard and still remains sufficiently porous to drain off water. In this respect it is much better than clean, new sand which is easily blown around by the wind when dry. In the vicinity of almost every shop there are vacant lots which require filling, and in this there is a source of profit to the wide-awake foundryman. In one case in Chicago, a foundryman was paying a teamster 25 cents a load to haul away his old sand and the latter was selling it to a contractor and builder, less than one mile away, for 50 cents a load. The teamster profited at the expense of the foundrymn's lack of enterprise. In another case, the owner of a block of property hauled material for two miles past the door of a large foundry in order to fill up a lot, while at the same time the shop was paying a railroad about $100 a month to get rid of its molding sand. Some ambitious foundrymen have made money by going into the real estate business, buying lots which are below grade at less than their actual value, filling them with old sand and then disposing of them at considerable profit.

The progress of the good roads movement has opened another avenue for the profitable disposal of molding sand. In many states broken stone is at a premium and foundry sand makes a good substitute. The burned sand is specially valuable for road building. For this purpose it is ground in a mill and preferably mixed with ashes from boilers.

Railroad Use

If the foundryman is so situated that he cannot get any return from his waste sand, he can at least make an effort to get rid of it without expense. In many localities shop owners are hiring railroads to haul away their burnt sand at prices ranging from 15 to 37 cents per ton. Not infrequently the railroad uses this material under its own tracks and buys more in addition. By a little bargaining on the part of the foundryman, the railroads would be glad to get the sand for nothing instead of charging to haul it away. Other foundrymen keep in touch with contractors and builders who can use refuse sand, in some cases it has been found advantageous to insert want advertisements in the daily papers in order to find suitable outlets for this material.

Many economies in the utilization of foundry sand may also be realized through the purchase of suitable equipment. Grab buckets, for instance, often reduce the cost of handling and loading old sand as much as 50 per cent. A foundryman in Wisconsin cut the cost of handling his old sand 20 cents a ton by purchasing a special drop bottom dump car in which it is hauled away to a fill. The value of rattlers and screens for reclaiming molding sand to be used in the core room has already been mentioned, while in large shops the efficiency of special sand-handling equipment is well recognized.

A meeting of foundrymen was recently held in Detroit for the purpose of considering the waste sand problem. On account of freight congestion at the Detroit terminals at certain seasons of the year, the railroads have refused to move old sand from foundries unless it is billed to a definite place and unloaded by the consignor. As a result of the conference, it was decided to address a communication to certain manufacturers of foundry equipment who might be interested in the development of a process for revamping old sand and treating new sand. The experiments will be conducted in the laboratory of a Detroit chemist. It is believed that a process can be developed for treating old sand so that 70 per cent of it will be again fit for molding purposes.

The 1914 Convention and Exhibition

At the recent meeting of the allied foundrymen's associations, held in Chicago, a joint convention committee was appointed to decide upon a place for the conventions and exhibition next year. Owing to the tremendous amount of floor space required for the exhibition of foundry equipment, it was found that only a few cities in the east could provide accommodations for the show and in view of the possibility of the conventions being held in New York or Philadelphia in 1915, it was decided to meet again in Chicago next year. The exhibition and conventions will continue from Sept. 7 to 12, inclusive, and the show again will be held in the International Amphitheater. The joint convention committee consisted of representatives from the American Foundrymen's Association, American Institute of Metals, Associated Foundry Foremen and the Foundry & Machine Exhibition Co.

Slow Melting

By W. J. Keep

Question.—We are experiencing trouble with slow melting. Our cupola is lined to 48 inches and our No. 9 fan operates at about 2,000 revolutions per minute. The fan is located at a distance of 16½ feet from the cupola, the fan opening being 14 inches in diameter and the pipe is of the same size. The blast pipe has two curves, but these are not abrupt. The cupola is equipped with six tuyeres, 6 x 12 inches, and six small round tuyeres, about 3 inches in diameter. We use a good grade of 72-hour coke. The charges consist of 2,000 pounds of iron on the bed, which contains 375 to 425 pounds of iron and 150 to 165 pounds of coke. We melt about 25,000 pounds of iron per heat and it requires from 2 to 2½ hours to melt. Kindly advise us how we can improve our operations.

Answer.—Your results and your equipment are good. However, I would suggest the installation of a blast gage on the blast pipe at the cupola. The blast pressure should be about 12 ounces. Leave the tuyeres as you have them at the cupola shell, but on the inside of the lining they should be only 4 inches high and as wide as they can possibly be made, so as to have a nearly continuous tuyere, and close the small tuyeres. The tuyeres should be 12 inches or more from the sand bottom. Make a slag hole at the back of the cupola and keep the slag running.

The Use of Cast Iron for Machine Tool Parts

Various Mixtures Employed for These Castings, With a Discussion of the Advantages Resulting from the Use of Chills

AN EXCEEDINGLY valuable investigation into the use of cast iron for machine tool parts was made by Henry M. Wood, of the Lodge & Shipley Machine Tool Co., Cincinnati. Letters of inquiry were sent to various manufacturers to ascertain their practice with reference to the cast iron mixtures they are using and the results recently were reported to the American Society of Mechanical Engineers.

When considering what kind of iron to use for various purposes, the machine tool manufacturer is interested chiefly in the result attained by the foundryman, i. e., the strength, soundness, hardness, etc., of the casting, rather than the foundry methods used in accomplishing such result. Nevertheless as an investigation of the character of the casting is made through chemical analysis, it is well first to consider the effect of each of the elements usually present in cast iron.

Influence of Elements

The five elements present in ordinary cast iron are carbon (both free as graphite and combined), silicon, sulphur, manganese and phosphorus.

Carbon exerts a more important and direct influence on the quality of the metal than does any other element. The percentage of carbon in the casting and the form in which it exists are dependent upon the melting conditions, the thermal treatment, and the amounts of other elements present. It, therefore, is necessary to take account of the effects of the carbon itself and the way its influence is modified by the presence of varying quantities of other elements. To obtain a proper relation between combined and free carbon is the most important point. The percentage of total carbon usually ranges from 3.5 to 4 per cent.

Graphite is merely mixed with the iron instead of being in chemical combination. Since it is only mixed with the metal it cannot exert any direct influence upon the properties of the molecules of the iron. So far as the graphite itself is concerned the toughness, hardness and melting point of the grains of the iron will not be altered. The tensile strength will, however, be greatly affected, since the interposition of the flakes of graphite will act as partings between the grains of the metal and reduce the cohesion. Iron high in graphite is soft and can be readily machined, but is of low tensile strength.

The carbon which is in chemical combination affects directly and greatly the properties of ordinary cast iron. It is the principal factor in determining the hardness, tenacity, soundness and freedom from internal stresses of the castings. In general, the percentage of combined carbon ranges from 0.05 in the softest cast iron to about 0.60 in iron of the highest elasticity. With suitable iron mixtures the amount of silicon and sulphur present regulates separation of carbon as graphite so that the amount of silicon present is an index of the relation between the free and combined carbon. Many analyses submitted do not state the percentage of carbon, perhaps because the foundrymen do not appreciate the importance of it, or perhaps because they consider the quantities of silicon, manganese and sulphur, which influence the quantity of combined carbon, make it unnecessary to determine the latter.

Silicon tends to cause separation of the carbon as graphite. As the hardening effect of the silicon necessary to do this is less than that of the combined carbon converted into free carbon the net result of adding silicon is softer iron. Under conditions which are easily regulated by selection of materials and in other convenient ways, the general influence of silicon can be utilized to render the cast iron suitable to various purposes, but it must be used with due regard to the other constituents of the metal.

Sulphur

The influence of sulphur is opposite to silicon, in that it makes the iron harder and more brittle. It makes the iron more sluggish when pouring and is liable to cause unsound castings. Sulphur increases shrinkage, resulting in internal stresses of unknown value and sometimes producing distorted castings. This element should be kept low, especially in small castings.

One effect of manganese is to combine with sulphur and go off in the slag. Another is to retard the separation of graphite by combining with carbon, and in this its influence is opposite to that of silicon, rendering the iron harder, stronger and perhaps closer.

Phosphorus lowers the melting point and increases the fluidity of the molten iron. On the other hand, phosphorus makes the casting harder, more crystalline and brittle, and reduces the tensile strength.

Semi-Steel

Semi-steel is obtained by charging mild steel scrap into the cupola. It is common practice to use about 20 per cent steel, but any amount up to 70 per cent may be used. The 20 per cent mixture usually gives the desired results for machine tool work. Semi-steel is lower in total carbon than cast iron, seldom having more than 3 per cent. The fine grain of semi-steel is due to low percentage and fineness of graphite. It is used for parts requiring good appearance, tensile strength and ability to resist shock. It is often used for large gear blank castings for various machine tools, for milling machine tables, knees and saddles, for lathe reverse plates, compound rests, etc. Tensile strength is relatively high and the grain of the casting is close.

Elements sometimes introduced into cast iron for special purposes are vanadium, titanium, nickel and chromium. Vanadium increases the ability of the casting to resist wear. Titanium combines with nitrogen and goes off in the slag, thus acting as a scavenger and making closer and cleaner iron. Nickel and chromium are now used to a limited extent in heavy chilled castings such as car wheels and rolling mill rolls. Their use might be desirable for special castings as it would doubtless increase the strength. But for machine tool work, the additional expense of such alloy castings might not be warranted, as today all parts where high tensile strength is required are made of steel.

In the belief that valuable information could be secured by a comparison of the present practices of representative machine tool manufacturers, a

number of makers in different lines and in different sections of the country were asked if they would be willing to submit an outline of their practice. The following excerpts pertaining to the mixtures used and chemical analyses of the castings are quoted from their replies:

A Builder of Special Machine Tools.—Our iron is bought on analysis specifications, covering two grades as follows:

No. 2 PLAIN	Per cent
Silicon	1.75 to 2.25
Manganese	0.60 to 0.90
Phosphorus	0.50 to 0.80
Sulphur	0.05 and under
No. 3	
Silicon	1.00 to 1.50
Manganese	0.50 and over
Phosphorus	0.50 to 0.80
Sulphur	0.07 and under

In addition to the above, we use materials as follows: No. 1 machinery scrap, mild steel scrap, manganese steel scrap. The last carries 12 per cent of manganese with quantities of the other elements so small that they are negligible in gray iron foundry work.

Our mixtures are figured on the actual analysis of each car, insuring in the castings uniformity of analysis and consequently of physical characteristics, such as strength, density and machining qualities. In general practice we use three different mixtures suited to our varying needs.

In our first mixture we include our lighter castings such as pulleys, small gears, washers, hand-wheels, brackets and the like. In this mixture we endeavor to have the following analysis:

	Per cent.
Silicon	1.90
Manganese	0.60
Phosphorus	0.70
Sulphur	0.08

This is usually secured by the use of a mixture of 50 per cent of two or three lots of No. 2 iron and 50 per cent of scrap. The proportions of the different pig irons are adjusted to produce the proper analysis in the mixture, and the scrap is partly our own foundry return and the balance No. 1 machinery scrap.

Our second mixture covers all our heavy work, such as planer beds, posts, tables, face plates, frames, etc. These castings require strength and sufficient density to permit the machined surface to take a high polish. These ends we accomplish by an analysis as follows:

	Per cent.
Silicon	1.40
Manganese	0.60
Phosphorus	0.60
Sulphur	0.09

This mixture consists of 45 per cent of two or more No. 3 irons and 55 per cent total scrap, shop and No. 1 machinery together. Should this mixture fail to yield sufficient manganese the addition of 1 to 2 per cent of manganese steel scrap is made to correct it.

The third mixture is semi-steel, used principally for large blank gears and castings requiring special strength. Its analysis follows:

	Per cent.
Silicon	1.20
Manganese	0.90
Phosphorus	0.45
Sulphur	0.09

Its average makeup is

	Per cent.
Machinery scrap	30
Mild steel scrap	20
Manganese steel scrap	5
No. 3 pig iron	45

The above mixtures cover our entire range of work except cases where some special composition is required or desired.

All materials are weighed before charging into the cupola and all due precautions are taken to insure proper melting conditions and perfect mixtures of the various materials entering into each charge.

Manufacturer of Precision Machinery.—In our work we run various grades of iron to meet the conditions existing in the machines or in the parts of machines under consideration.

In a general way our mixtures, in per cent, run as follows:

Silicon, Per cent.	Manganese, Per cent.	Phosphorus, Per cent.
3.00	0.60	0.80
2.40	0.65	0.70
2.00	0.65	0.60

The first is for the average run of castings of smaller size; the second for the larger castings. Where we need a special, close-grain iron we use the third mixture.

Manufacturer of Milling Machines.—We have never carried on any extensive experiments to learn the best mixtures of cast iron for our purposes. We use in the tables, knees, saddles and vises about 20 per cent of steel with a view to obtaining a close-grain casting, and increasing somewhat its strength.

We use practically no cast iron for gears or small parts, these being made of steel, drop forged in the case of larger parts, and also in the case of smaller parts when not adopted for manufacture from the bar.

The subject of gray iron castings is, we believe, one of the most annoying to be found in connection with the manufacture of machine tools. Customers are not satisfied to accept machines with defective castings even though the deficiency is of such a nature as to, in no wise, impair the life or efficiency of the machine.

The ideal casting is, of course, one that is so close as not to show any grain when finished and at the same time, just as hard as it can be, and be worked into shape.

The question of strength is probably not so important, as there is opportunity to use sufficient bulk to obtain strength. At any rate this is true of the parts that we make of cast iron, for, as stated above, all our gears and like parts are made from steel which is case-hardened.

Manufacturer of Heavy Lathes.—With the heavy castings we are using a semi-steel mixture with about 20 per cent of steel. The analysis of this iron shows 1.60 to 1.70 per cent silicon; 0.65 to 0.75 per cent manganese; 0.40 per cent phosphorus, and 0.8 to 0.10 per cent sulphur. While our carbons are not noted as a rule, we get a check on these every once in a while, showing the total carbons about 3.50 to 3.60 per cent.

Our iron for smaller pieces runs from 1.80 to 1.90 per cent silicon; 0.40 to 0.50 per cent phosphorus; 0.65 to 0.70 per cent manganese, and 0.07 to 0.010 per cent sulphur. The total carbon shows up practically the same in both mixtures. Our test bars on the first mixture break at from 2,800 to 3,200 and on the latter mixtures at about 2,600. This refers to 1 by 1 inch standard bars supported on 12 inch centers.

Manufacturer of Grinding Machines.—We use castings with various proportions of steel according to the size of the casting and the place where it is to be used, so that today we have very bright, lustrous surfaces and it is possible to get accurate alignment.

Chilling Castings

There is a wide difference of opinion among machine tool manufacturers as to the desirability of chilling any surfaces of castings. The writer asked some of the representative manufacturers of various classes of machine tools for their experience on this point. The following quotations from their replies state both sides of the case:

A Manufacturer of Milling Machines.—We are not using any chills at this time, though we have experimented with these from time to time, but have reached no satisfactory conclusion.

A Lathe Manufacturer.—We have not used chills on any parts of our machines, which, we must concede, is from many points of view, not a very satisfactory admission to make.

A Manufacturer of Heavy Machine Tools.—For quite a period, about nine or ten years ago, we chilled the ways on our lathe and also the rails on our boring mills. We found, however, after they had been out some time that there was quite a bit of trouble with the chilled surfaces scratching. It was hard for us to find exactly what was the root of the trouble and we finally gave it up. The effect of the scratching of the chilled ways was a most peculiar one, and we sometimes observed on a machine even before it had gone out that some little particle of material had settled on the way and scratched the same badly.

A Manufacturer of Grinding Machines.—In regard to chilled iron, of course, you know that chilled iron means this and nothing else: It means iron that cannot be filed, planed or scraped. At least any mechanic who hears the words *chilled iron* understands it to mean just that thing, a surface that cannot be cut with tools. Now, of course, you realize that such a surface makes it impossible to get practical aligning ways on machine tools. It might just barely be possible to grind them accurately, but probably not practical to do so. We use an iron with steel mixture, and vary the mixture according to the size of the casting, and we produce a casting as dense and as hard as we can possibly plane and scrape with any surety of getting perfect alignment, because imperfect bearing and imperfect alignment is just as bad and just as sure an error as iron that would be too soft. In fact, if one had iron that was exceedingly soft, and should choose to make ways which are very wide it might be more durable than one made with hard iron and smaller ways.

Another Manufacturer of Grinding Machines.—The main reason for chilling the different parts of our work is to increase the wearing durability and at the same time get the advantage of refining the metal and a clean surface.

The parts chilled are the guides of the carriage and the surface of the table upon which the head and tailstocks are mounted.

Our method of chilling is to place plates of ⅝ inch in thickness in the mold, and these give a depth of chill of about ½ inch and a degree of hardness just to the point of where the machining can be readily done.

It would be natural to suppose that this chilling would produce or increase internal strains, but on our work, such conditions have not given any trouble.

Our work is not of such a nature where hammering upon it or peening is necessary. Therefore, we are unable to state just what action would take place as the result of hammer blows and peening.

The chilled surfaces are very much more durable than metal in the ordinary condition, and we believe by the chilling process the durability of the surface upon which wear comes is increased at least from 300 to 400 per cent.

A Builder of Heavy Machine Tools.—In 1888 we began the practice of solidifying cast iron surfaces by introducing chill blocks in the molds, and we have continued the practice ever since.

Answering your questions specifically, first, we have not discontinued the use of chilled surfaces because of any difficulty in oiling. We have never found that the fine grain of the chilled iron prevented the oil from sticking. There is no truth in the statement.

We have not found any increase in internal strains due to the use of chills. On the contrary, when chills are properly placed they equalize the cooling of the heavy parts adjacent to lighter portions and reduce the internal stresses which would naturally result from the difference in time of cooling. If the chills are improperly used it would be possible, especially in thin castings, to cool the entire mass too rapidly and produce internal stresses.

Chilled Surface More Durable

We have not found that the proper use of chills makes the iron more sensitive to a peening action; in fact, we have evidence to the contrary.

The chilled surface we believe to be more durable. We have cases where gearing made in this way outlasted several sets made in the old manner.

The success or failure of this process depends upon the ability to produce, day in and day out, the kind of metal required, and, further, the intelligent designing of chills of iron molds so that a proper relation may always be observed between the size and shape of the casting and the thickness of the mold or chill block.

A Boring Mill Manufacturer.—We are chilling certain surfaces on our boring mill spindles with good success, but have found no occasion for chilling any other surfaces. If we experienced difficulty due to undue wear on sliding surfaces, we would increase the area of the surfaces and supply better lubrication and protection from dirt rather than try to chill the surfaces of these parts.

The chills which we use on our spindles serve two purposes: First, by securing closer grained metal; second, by improving the quality of the wearing surfaces. We found that it was difficult to get good castings of these spindles until we did use chills.

A Builder of Special Machine Tools.—Concerning chills, we would say that to some extent we are now using these on the surfaces of beds and similar castings.

A Manufacturer of Precision Machinery.—We use such chills as may be necessary to give the surface in connection with the ways and moving parts.

Chilled Lathe Beds

In view of the differences in opinion of the value of chilled surfaces and the ideas held by some that it is impossible to chill an iron of high tensile strength without making it so hard it cannot be machined, the practice of the Lodge & Shipley Machine Tool Co., is here outlined.

Three average analyses follow:

Silicon, per cent.	Sulphur, per cent.	Phosphorus, per cent.	Manganese, per cent.	Tensile strength, lbs. per sq. in.
2.16	0.065	1.01	0.40	22,310
2.17	0.065	1.01	0.39	24,840
2.45	0.076	0.63	0.71	24,195

The first analysis is of a specimen taken in January, 1913, from the first iron run in a heat; the second, from the last iron of the same heat; the third, from the average iron of a heat in September, 1913.

This same iron is used for lathe beds of which the ways are chilled, also for other cast iron parts which do not require the high tensile strength of semi-steel. For some parts, such as compound rest top slides and reverse plates, we use semi-steel. Parts subject to greater stress or to severe shock are made of steel.

In a 30-inch bed the close iron produced by the chill extends to a depth of 1½ to 2 inches below the finished surface of the ways, thus proving that the chilled iron is not all removed in the planing.

Scleroscope tests on chilled beds, finish-planed but not scraped, gave as a result of eight different tests on four different beds, scleroscope readings of 40 to 42 with an average of 41. Similar tests on chilled beds which had been planed and then scraped gave a practically constant scleroscope reading of 42. Comparative scleroscope tests on a heavy section of unchilled cast iron which would give as nearly as possible conditions parallel to those just quoted gave readings ranging from 18 to 22, with an average of 20.

These tests indicate that the chilled ways are twice as hard as the unchilled. The same is also shown by the planing speed, as we can only plane the chilled beds at a trifle less than half the cutting speed formerly used.

In addition to the advantage gained by the hardness, the chilled beds are if anything more uniform than the unchilled. The rough beds as received from the foundry are quite straight, so that the amount of metal removed all along the ways in planing is as nearly uniform as is practicable. Then, too, the scleroscope readings indicated a more nearly constant degree of hardness on the chilled beds than on the unchilled. Fewer castings are unsound than before chills were used.

The chilled surface is produced by a series of cast iron chill plates each about 6 inches long placed end to end in the mold. The use of separate short plates eliminates much of the warping and twisting which would occur in a long chill plate.

If a thick chill plate is used with a low-silicon iron the surface of the casting is chilled so hard that it cannot be machined. The desired result is attained by regulating the thickness of the chill plate to suit the size of the casting for which it is used; then a low silicon iron of high tensile strength can be successfully poured. The heavier the casting, the thicker the chill plate.

The action in the mold is that when the molten iron strikes the cold plate it is chilled and hardened; then the heat in the mass of iron forming the body of the bed casting gradually warms the chilled surface and the chill plate, thus annealing the casting or *drawing the chill,* just as when in tempering a chisel the heat in the shank of the chisel *draws the temper* of the cutting edge to the proper point after the cutting edge has been hardened by quenching in water. This annealing of the chilled surface of the casting produces the desired form of hard, close-grained gray iron.

The thickness of the chill plate used is such that the heat in the casting will anneal the surface sufficiently to permit planing, although at a greatly reduced cutting speed, and yet retain the benefits of the chill.

Value of Chilled Surfaces

The advantages of chilled wearing surfaces for machine tools are:

Much harder surfaces, which experience has proved are vastly more durable than similar unchilled surfaces.

A hard guiding surface with a relatively soft carriage, bringing the bulk of the wear on the carriage and thus maintaining the alignment of the guide.

A denser and much more closely grained surface of the casting, giving better appearance.

An exceptionally smooth finished surface, in which there are no pores where dirt and grit may become imbedded to cause rapid abrasion of the other bearing surface.

Chilled surfaces are more advan-

tageous on some machines and some parts than on others. In the case of a lathe the carriage will often be used for long periods of time on chuck work or on short jobs between centers which brings all of the wear on a comparatively short length of the bed just in front of the headstock; such uneven wear on the unchilled bed destroys the accuracy of the alignment for long work. Chilling the ways brings the wear principally upon the carriage, and even if the carriage is worn, the alignment at all points along the bed will remain relatively true.

Advantages

The experience of the Lodge & Shipley Company, based on the use of chilled ways on beds of all sizes of lathes for more than two years, is that no internal stresses are created by the chilling; that the surface is not made more susceptible to a peening action; that the surface can be equally as well lubricated as before; that iron of high tensile strength is used; and that the increased hardness and closeness of grain of the chilled surface vastly increases the durability and permanency of alignment.

As the letters received from other machine tool manufacturers do not state tensile strengths, the following statements regarding the general practice of Cincinnati manufacturers are quoted:

A Professor of Mechanical Engineering and Testing.—I believe the general Cincinnati machine tool practice for good castings runs from 22,000 to 24,000 pounds per square inch tensile strength, but owing to the great variety I would not wish to commit myself to any particular figure.

A Cincinnati Chemist.—After tabulating the results of my tests of the tensile strength of cast iron from various sources, I pick some at random to show the average run of machine tool iron in pounds per square inch in this locality: 22,962; 24,090; 24,522; 23,197; 23,260.

This will give an idea of what the general run is. Good machinable iron, where the grain does not have to be too close for machine tool work, should run from 20,000 to 26,000 pounds per square inch. Low tensile strength is due to too much silicon, sulphur, or phosphorus.

Chilled surfaces for certain parts are desirable. There is a wide difference in the chemical analyses of irons used by representative manufacturers; this last circumstance may be due to the different melting conditions in the several foundries; or it may indicate a field where much good could be accomplished by a more complete interchange of information, and by experiments to determine the best mixtures for different purposes.

Pertinent, Practical Pointers

BE SURE there is enough metal in the ladle before pouring the job.

Learn how to calculate the quantity of metal required to cast your work.

Always allow for runners and risers about 25 per cent above the quantity of metal required to fill the mold.

Do not guess the amount of metal required, it is dangerous, and is the cause of many wasters. It is usually left to the foreman to calculate the amount of metal required for each mold, but there is no reason why you should not learn to do it also, for some day a leading hand or foreman will be wanted, and you should be prepared to fill the place.

No man is fit for the position of foreman unless he knows how to calculate the metal required for a mold.

There is no time to learn after you get the position, so begin to learn at once and give up guessing.

Do not let metal set in the bottom of the ladle; it spoils the chances of the next job poured from that ladle.

Study the job before deciding where it shall be run and where the riser shall be placed.

A number of small runners are far better than one large one.

See that the metal has the clearest flow possible when entering the mold at the runner.

Risers relieve the strain on the mold and are convenient for feeding any heavy section of a casting.

Do not depend on a riser taking off any dirt; it does not do so. Be sure the mold is clean.

Be sure the metal is in the right condition for pouring the job; for it is possible to cast a mold too hot as well as too cold.

Castings for different purposes and of different design require different mixtures of metal and different treatment.

Do not be wasteful in the use of the tools and materials supplied for your use. Your employer has to buy them, and the more he has to spend in this way, the less able will he be to give you an advance in wages.

Do not unnecessarily loosen patterns, for, not only will you loosen parts of the mold, but the pattern will probably suffer damage. All patterns will not stand the hammer.

Be sure that all clamps are sound and that you have enough weight on the job to resist the strain.

When you have once made a job successfully, do not vary the method of making it, as in doing so, you will be liable to make wasters.

Keep the mold joints clean, for a dirty or ragged joint is the forerunner of a run-out and a possible waster.

Keep on good terms with the foreman if you wish to learn all branches of the trade.

Apprentices cannot afford to lose the good will or friendship of anyone in their shops.

A good apprentice will make a good journeyman.

Never allow yourself to think you have learned the entire molder's trade, for one's knowledge can constantly be increased.

Always remember that it is to your advantage to be the best man in the shop.

Be at your work first thing in the morning. You may get a superior job on that account.

Ask the foreman when in doubt. Don't *chance it.* The foreman is responsible.—*Foundry Trade Journal.*

Pitted White Iron Castings

By W. J. Keep

Question.—We are making a large number of white iron rolls and would like to know how to prevent the formation of pits in the side opposite the point at which the castings is poured.

Answer.—Without an analysis of your mixture and the grade of fuel you are using, it is almost impossible to diagnose your trouble. I will presume, however, that your coke is too high in sulphur and would suggest that you have an analysis made to ascertain whether this is the case. White iron always is high in sulphur and no more should be added in the fuel than is absolutely necessary. Probably you are using scrap from smelting plants in your vicinity and if this is the case, this also will contain an excess of sulphur. The scrap for work of this kind should consist of car wheels or plow points. You might add 10 pounds of lump ferro-manganese to each 1,000 pounds of iron charged. If that does not prevent your difficulty, add powdered ferro-manganese in the ladle. This addition should be made in the proportion of 1 per cent. If the trouble still persists, place 0.1 per cent of pure aluminum in the ladle before catching the iron.

How One Iron Foundry Records Its Operations

The System Installed by the Rutenber Motor Co., Which is Applicable, in Part at Least, to the Methods of Other Shops

By C S Taylor

IN THE complex activities of a modern shop, a system of records, which enables the management to keep in touch with the details of the business, is essential. To meet this necessity, every plant is provided with an assortment of forms or blanks, on which the results of each day's work are, or should be, recorded and summarized. In a great many cases the forms used are the result more of circumstance than of design; as the business grows and the need for definite, written information increases, new blanks are added from time to time without much regard for what has gone before, and the final result is an unwieldy, expensive and cumbersome "system" that defeats its own end. Adequate, accessible records are an essential to scientific management, but a mass of ill-assorted, undigested reports are sometimes worse than none at all.

Foundry Cost Forms

In the foundry business especially it is necessary that the system of records be simple and so correlated that but little clerical labor is required, for the industry is not one which can be safely burdened with a large overhead. The accompanying illustrations show a complete system of record forms designed for the foundry of the Rutenber Motor Co., Logansport, Ind. This company operates a shop employing a large number of men, turning out 35 tons of gray iron and 10 tons of aluminum castings daily. The plant has a total of 60,000 square feet of floor space. In all, 26 forms are used and they may be divided naturally into five groups; employment forms, Figs. 1 to 5; wage payment forms, Figs. 6 to 12; cost record forms, Figs. 13, 14, 18, 19 and 20; order tracing and shipment forms, Figs. 15, 16, 17, 21, 22 and 23, and miscellaneous forms, Figs. 24 to 26.

Practically all of the forms are self-explanatory, but for convenience the purpose and principal details of each will be given. The dimensions are in inches with the width given first.

FIG. 1.—Notice of Employment or Change of Rate; 4 x 6, white card.

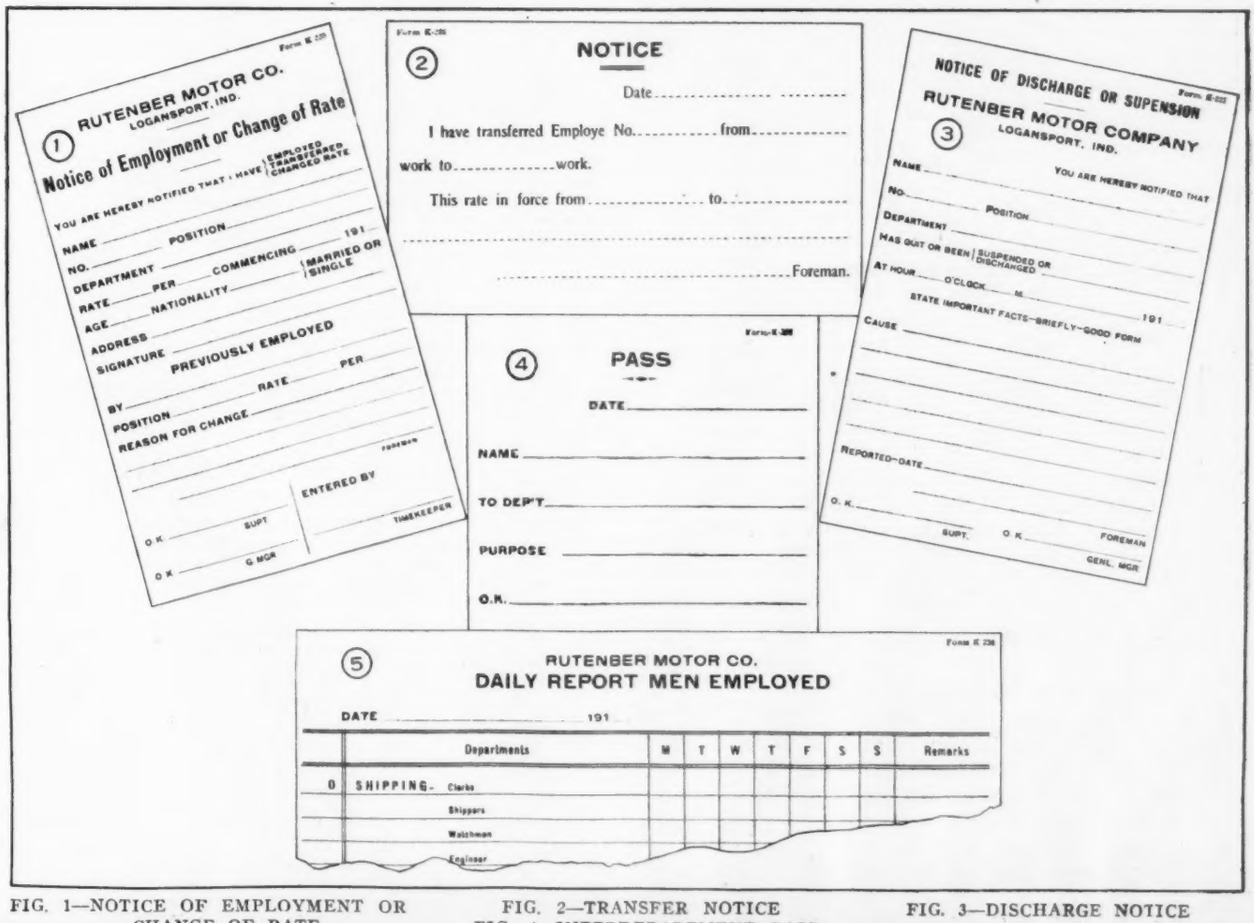


FIG. 1—NOTICE OF EMPLOYMENT OR CHANGE OF RATE
FIG. 2—TRANSFER NOTICE
FIG. 3—DISCHARGE NOTICE
FIG. 4—INTERDEPARTMENT PASS
FIG. 5—DAILY COMPARATIVE REPORT OF MEN EMPLOYED

This blank is filled out by the foreman and contains not only a concise record of individual facts regarding each employe, but is the timekeeper's authority to enter the name on the payroll. It prevents the introduction of "straw men" on the roll unless there is collusion between the foreman, timekeeper and superintendent.

FIG. 2. — Transfer Slip; 5½ x 3½, white. This is a simple notice to the timekeeper that a man has been transferred from one kind of work to another, involving a change in rate of wages.

FIG. 3.—Notice of Discharge or Suspension; 4 x 6, pink. The principal feature of this form is that it must give a reason for the discharge or suspension. It is the timekeeper's authority to pay off the man, and its pink color prevents its being confused with the employment slips, Fig. 1.

FIG. 4.—Pass; 3½ x 4, yellow. In order to prevent waste of time and infractions of discipline, workmen are not permitted to leave their own department. If business takes them to any other department than their own, they must be provided with a pass properly approved.

FIG. 5.—Daily Report of Men Employed, 8½ x 11, white. Printed on both sides to save space, this record is made up by the timekeeper and handed to the general manager every Monday. It shows exactly the number of men employed in each subdivision of every department for any given week and forms a continuous record of the fluctuations in the working force. The various subdivisions on this report blank follow:

0—SHIPPING—
Clerks.
Shippers.
Watchman.
Engineer.
Electrician.
Firemen.
Inspectors.
Millwrights.
Blacksmiths.
Rattlers.
Testers.
Yard Laborers.

1 A—G. I. FOUNDRY (cylinder section)—
Molders (cylinder).
Molders (other).
Laborers (foundry).
Laborers (yard).

1 B—G. I. FOUNDRY (machinery)—
Molders.
Laborers (foundry).
Laborers (yard).
Laborers (cupola).
Laborers (miscellaneous).

2—GRAY IRON (core)—
Coremakers (cylinder).
Trimmers (cylinder).
Grinders (cylinder).
Trimmers (other).
Grinders (other).
Extra laborers.

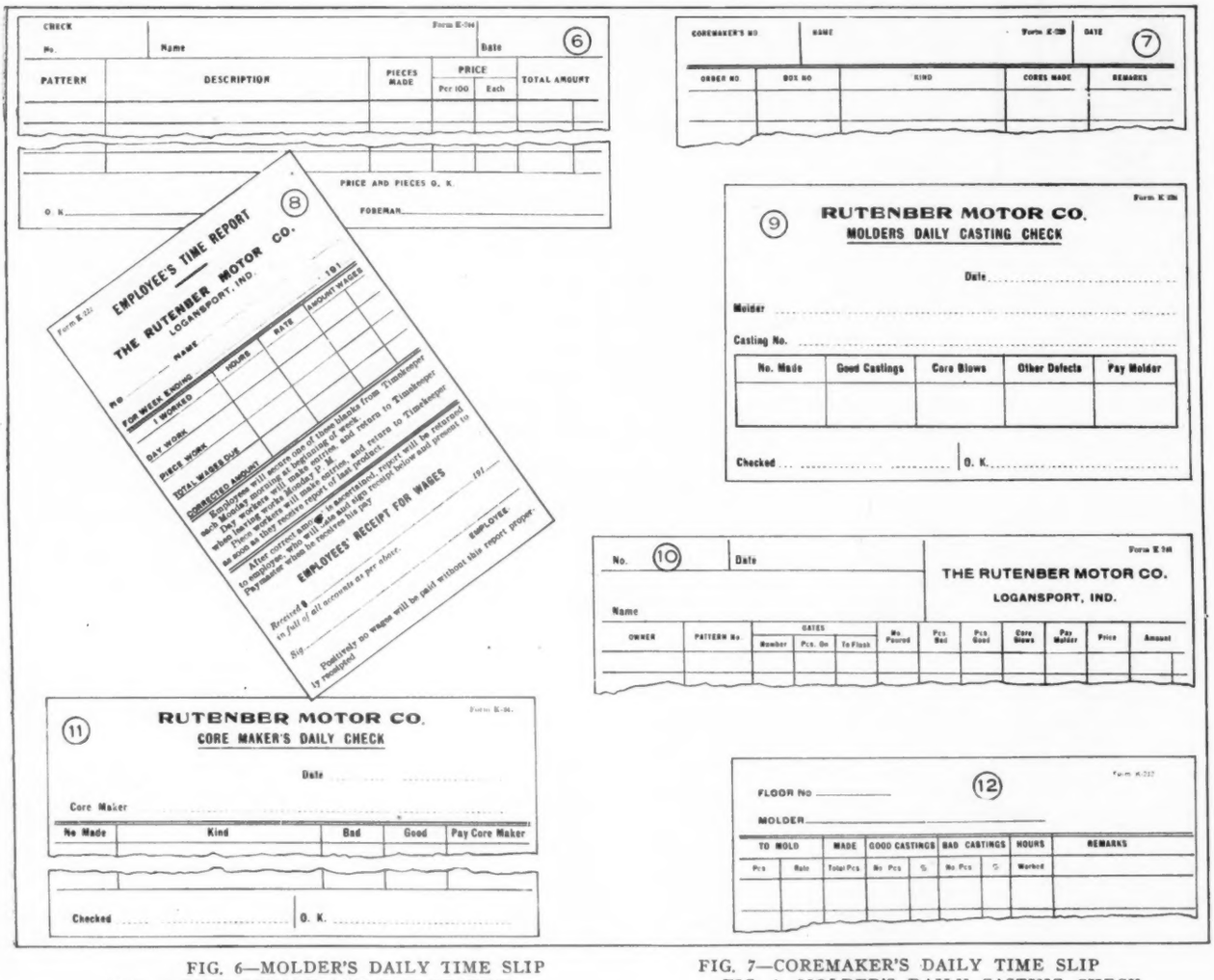


FIG. 6—MOLDER'S DAILY TIME SLIP
FIG. 8—TIME REPORT AND PAY RECEIPT
FIG. 11—COREMAKER'S DAILY CHECK

FIG. 7—COREMAKER'S DAILY TIME SLIP
FIG. 9—MOLDER'S DAILY CASTING CHECK
FIG. 10—LABOR COST RECORD
FIG. 12—MOLDER'S WEEKLY PRODUCTION RECORD

3—PATTERN SHOP—
Patternmakers (wood).
Patternmakers (metal).
Machine hands.
Carpenters.

4—ALUMINUM FOUNDRY—
Molders (aluminum).
Molders (brass).
Furnace tenders (aluminum).
Furnace tenders (brass).
Laborers (foundry).
Coremakers (other).
Coremakers (machinery).
Oven tenders.
Sand mixers.
Core carriers.
Trimmers.
Pasters.
Miscellaneous.

Laborers (yards).
Miscellaneous.

5—ALUMINUM CORE DEPARTMENT—
Coremakers (aluminum).
Coremakers (brass).
Oven tenders.
Sand mixers.
Core carriers.
Trimmers.
Miscellaneous.

6—A & B TRIMMING DEPARTMENT—
Trimmers (aluminum).
Trimmers (brass).
Grinders (aluminum).
Grinders (brass).
Miscellaneous.

FIG. 6.—Molder's Daily Time Slip, 7¼ x 5¾, white. On this blank each molder enters his time and an account of his day's work. When approved by the foreman, the slip goes to the timekeeper and forms the basis for the payroll. The cleaning room foremen, however, send in a daily list of bad castings, which are charged back to the various molders.

FIG 7.—Coremaker's Daily Time Slip, 6 x 4, white. Similar in purpose to the Molder's Daily Time Slip, Fig. 6.

FIG. 8.—Time Report and Pay Receipt, 3¾ x 5¾, pink. An individual weekly record of each man's work, together with a receipt for his wages, filed by the cashier.

FIG. 9.—Molder's Daily Casting Check, 6 x 4, white. The timekeeper hands this slip to the molder for his information. It shows the charges made for bad castings and the amount of pay due for each day's work.

FIG. 10.—Labor Cost Slip, 7½ x 5½, white, A daily report sent by the timekeeper to the cost clerk for entry on individual cost cards, Fig. 14.

FIG. 11.—Coremaker's Daily Check, 6¼ x 5, white. Similar in purpose to the Molder's Daily Casting Check, Fig. 9.

FIG. 12.—Molder's Weekly Production Record, 5½ x 9½, white. A form handed to the general manager each week showing the individual record of each man and the condition of his work.

FIG. 13.—Daily Melting Report, 11 x 8½, white. These reports are furnished the cost department every day by the superintendents of both the gray iron and aluminum foundries. They contain the data from which the cost of metal in the castings is computed.

FIG. 14.—Individual Labor Cost, 5 x 3. white card. A complete card index record of the molding and core labor cost of each job. It also gives the number of molds made per day, the per cent of good castings and other vital information used in estimating on new jobs.

FIG. 15.—Foundry Order, 4⅝ x 8½, buff card. A record form kept by the

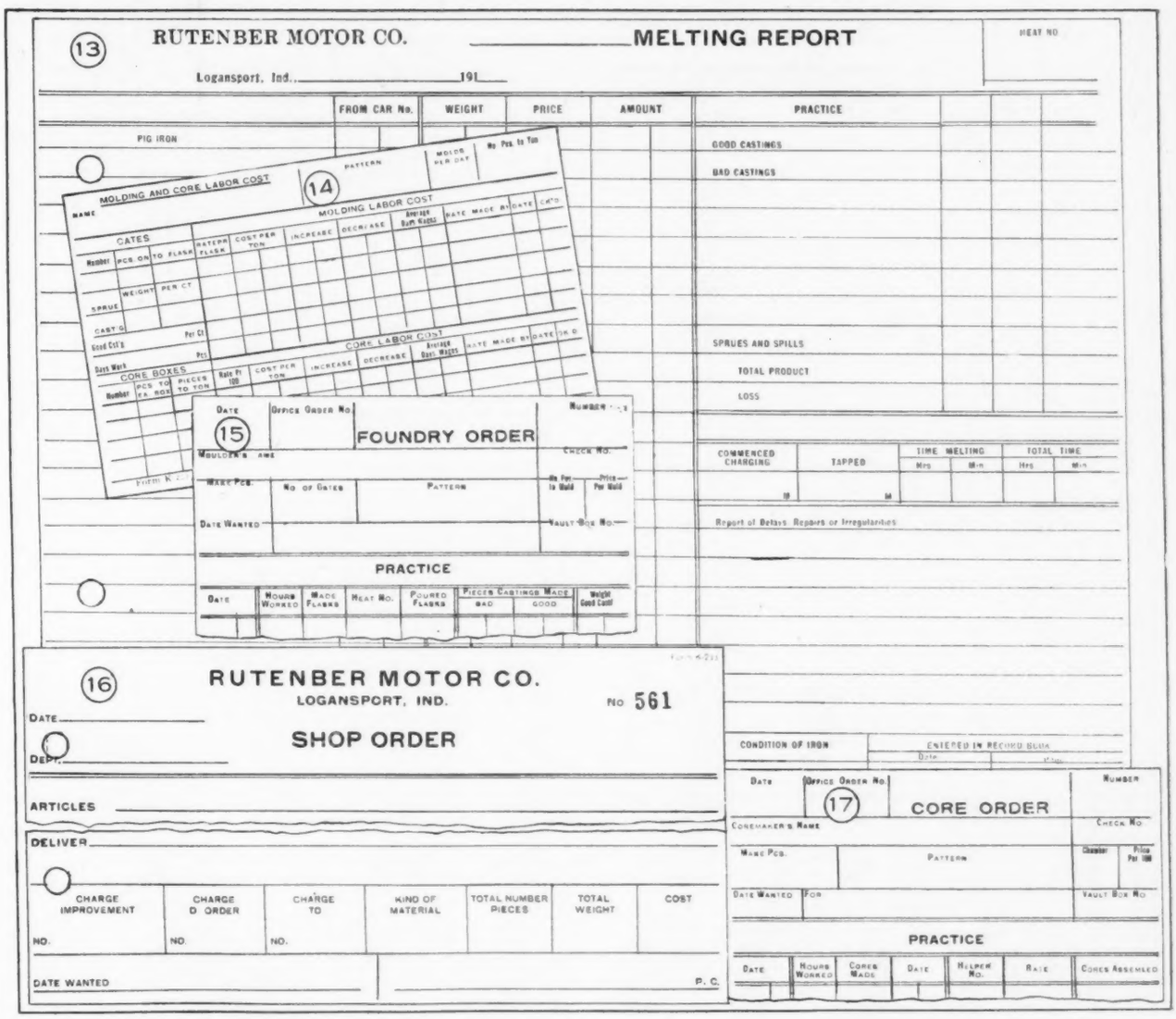


FIG. 13—DAILY MELTING REPORT
FIG. 14—INDIVIDUAL LABOR COST CARD
FIG. 15—FOUNDRY ORDER
FIG. 16—SHOP ORDER
FIG. 17—CORE ORDER

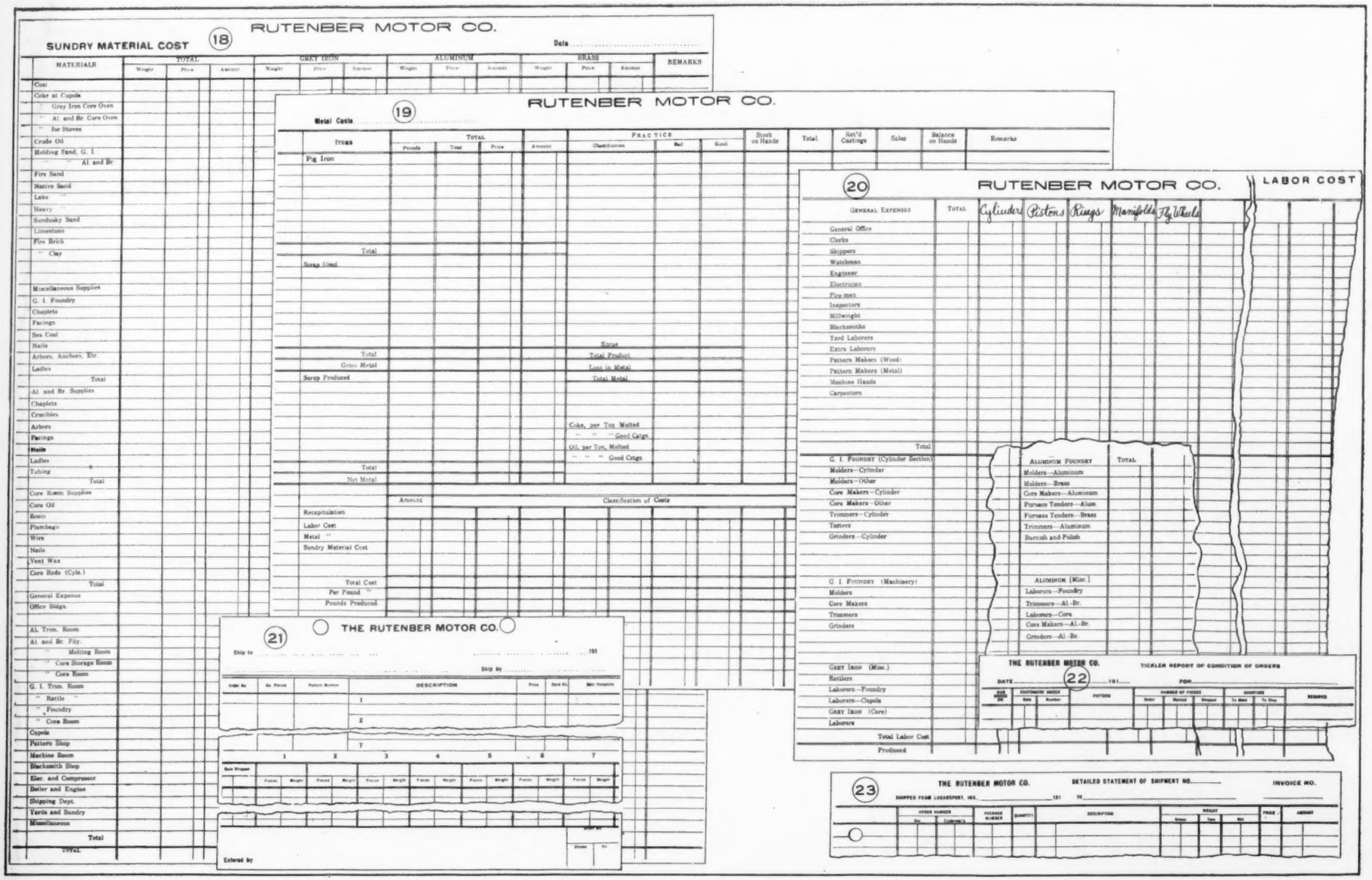


FIG. 18—MONTHLY RECORD OF SUNDRY MATERIAL COSTS FIG. 19—MONTHLY PRACTICE SHEET FIG. 20—MONTHLY RECORD OF LABOR COSTS
FIG. 21—RECORD OF ORDERS RECEIVED AND SHIPMENTS MADE FIG. 22—TICKLER REPORT SENT IN ANSWER TO CUSTOMER'S INQUIRY
FIG. 23—SHIPMENT REPORT

foreman, showing the data regarding each individual order and the history of the job.

FIG. 16.—Shop Order, in duplicate, 7½ x 5, white original, and yellow, copy. A standard shop order form sent by the office to the shop as authority for the execution of any given job.

FIG. 17.—Core Order, 4⅝ x 8½, buff card. Similar in purpose and character to Foundry Order, Fig. 15.

FIG. 18.—Sundry Material Cost, 16 x 20, white. A monthly report for the general manager showing in detail the cost of supplies charged to each department.

FIG. 19.—Practice Sheet, 18 x 13½, white. A monthly report of metal costs made up for the general manager from the Daily Melting Reports, Fig. 13.

FIG. 20.—Labor Cost Record, 25 x 14, white. A monthly record of labor costs subdivided according to kind of labor and according to product made. This form shows, for instance, the amount of coremaker's labor charged to flywheels in any given month.

FIG. 21.—Record of Customer's Order and Shipments, 9⅜ x 11¾, white. The upper half contains a description of each piece mentioned in the customer's order and the lower a record of the shipments, forming a continuous inventory of the condition of the order.

FIG. 22.—Tickler Report of Condition of Orders, 8½ x 10¾, manila. When a customer inquires about his orders, this form is filled out from the shop records and mailed to him; a copy also goes to the department foremen.

FIG. 23.—Shipment Report, in duplicate, 11½ x 7¾, white original, and 9½ x 7¾ yellow, copy. This record is made out for every shipment. The original is sent to the accounting department as a basis for the charges on the customer's monthly statement; the copy with the price columns omitted is sent to the customer with the bill of lading.

FIG. 24.—Pattern Record, 10 x 8, white card. A card file showing details regarding each pattern in the pattern storeroom.

FIG. 25.—Requisition, in duplicate, 7¼, x 5½, white original and yellow, copy. Supplies required from the storeroom by any department are ordered on this form.

FIG. 26.—Repair Order, in duplicate, 8 x 5½, white original and yellow, copy. No repairs can be executed without this order.

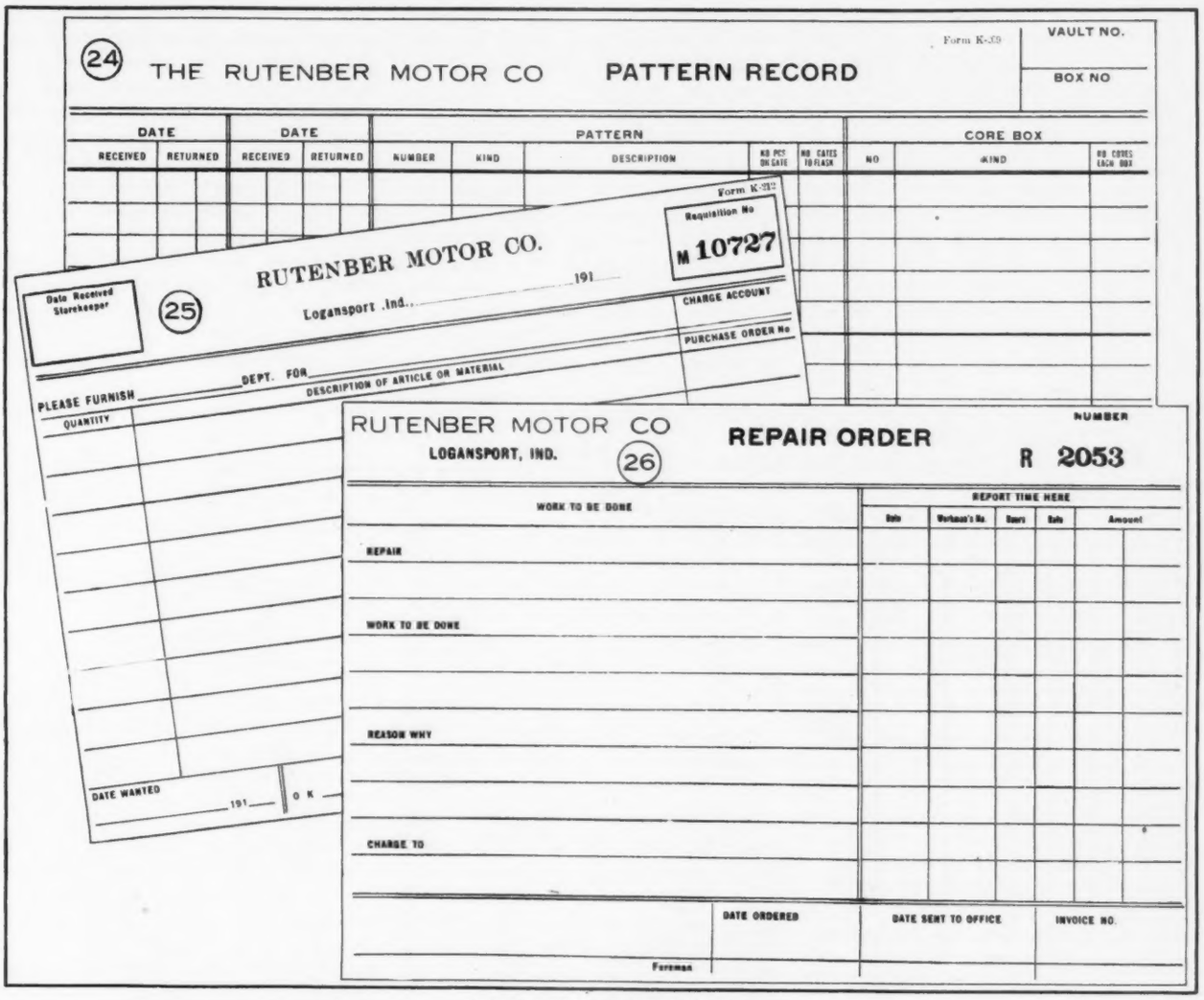


FIG. 24—PATTERN RECORD
FIG. 25—REQUISITION ON STORE ROOM FIG. 26—REPAIR ORDER

A Nickel Alloy

Walter Rubel, of the Rubel Bronze Co., London, Eng., recently was granted a patent on a nickel, iron, aluminum and manganese alloy, consisting of nickel, 32 parts; iron, 31 parts; aluminum, 30 parts, and manganese, 7½ parts. This alloy is to be used with other metals to form other mixtures, and may be added to copper and aluminum to form a bronze.

How Economies Can Be Effected in Core Shops*

A Discussion of the Coremaker's Vexing Problems With Suggestions for Overcoming His Many Difficulties

By O F Flumerfelt

IN THESE days when the industrial expert is looking into every branch of industry with the purpose of cutting out leaks in profit, it is not surprising that the core room should receive its share of attention, for of all departments of the foundry business it is undoubtedly true that the core room has been the most sadly neglected.

For the purpose of study and analysis, the general problem may be approached from several points which constitute the different phases in the production of cores. These are as follows:

(a) Foundry requirements to be satisfied.
(b) Selection of sands and binders.
(c) Oven and baking conditions.

poured. Storage may be so limited that cores have to be made, baked, and used hand-to-mouth so to speak. All these factors are foundry conditions which must be satisfied, and hence, the character of cores will be governed very largely by these.

Selection of Sands and Binders

The class of metal will determine the kind of sands used, and these in turn will call for particular classes of binders. Steel and iron requires nearly pure silica sand and most of the bond is burned out of the core each time; aluminum and brass allow more clay in the sand, and much of the bond remains. At present the sand is thrown away in the majority of foundries after using it once. Several experiments have been carried on in the past year or so with the idea of using old sand again. In one instance it was found possible to use 80 per cent again. The chief difficulty of course is the fine dust which consumes binder, and also destroys the vent. This had led to the problem of cleaning, of which there are two general methods: (1) the dry, in which the fine particles are blown or drawn out by a current of air, and (2) the wet, in which water carries away the finer material during mechanical agitation.

If the molding is in green sand and the cores have to stand in the mold quite a while, then a waterproof core is essential. This is obtained by the use of oil as a binder. When oil alone is used, the sand should contain as little clay as possible. The writer in one experiment used a silica sand and obtained a tensile strength of 130 pounds; upon using half this sand and half of another containing some clay, the strength fell to 40 pounds or less than one-third, even when using the same ratio of oil to sand. Then, too, there are so many core oils on the market now that much care must be exercised in the selection of the proper oil. A test was made on two oils costing exactly the same price; they were used in the same ratio, and the cores baked on the same plate. One oil proved to be 25 per cent stronger than the other.

In another instance an oil was being used which cost 30 cents per gallon; it was found on testing that an oil costing 50 cents per gallon could be used at less than half the ratio. This one item for the foundry in question (and it may be remarked that their oil consumption was comparatively small) amounted to a saving of between $400 and $500 per year.

If the cores do not stand long in green sand, or if dry sand work is being made, then we can substitute water soluble and dry binders in the place of part or all of the oil; moreover the presence of clay seems to affect this class of binders less, and in some cases actually proves beneficial. Among these may be mentioned glutrin, dry pitch compounds, flour, dextrin, etc.; and there may be as much variation in quality of these as in the case of oils.

Another problem is the combination of

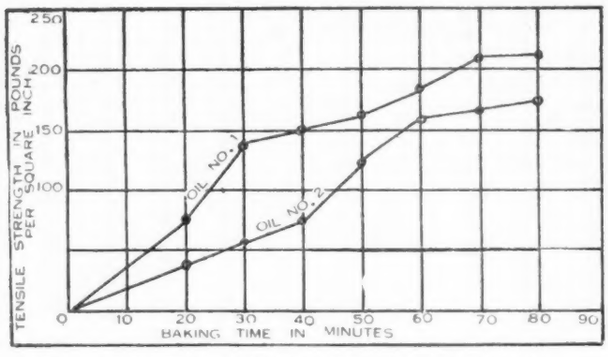


FIG. 1—RESULTS OF USING THE SAME SAND AND DIFFERENT OILS

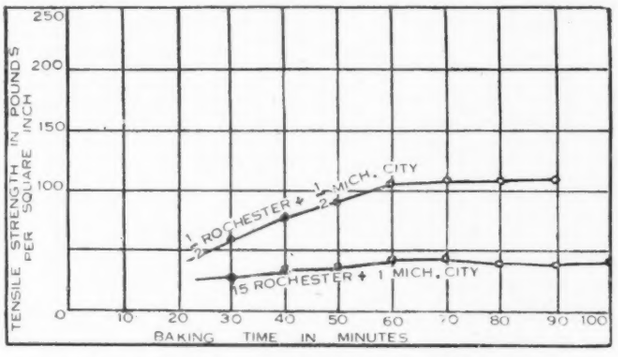


FIG. 2—RESULTS OF USING THE SAME OIL AND DIFFERENT SAND MIXTURES

(d) Mixing and delivery of sand, plates and driers.
(e) Handling of raw and baked cores.
(f) Proper placing of responsibility.

Each of these will be taken up in more detail, considering first the foundry requirements to be satisfied.

The class of work in hand may be heavy, requiring very strong cores or light requiring less strength. The core will have to be just strong enough to withstand the necessary pressure, and any excess strength over that simply means that much harder problem in cleaning, and that much waste in binder. The molding may be dry sand or green, and if green, perhaps the moisture content will vary considerably from time to time. The arrangement of floor space may be such that molds have to stand quite a while, or even over night before being

*Presented at the Chicago convention of the American Institute of Metals.

binders; some work well together, others do not. A striking example of this occurred a short time ago when a core room foreman attempted to use flour and oil together. The mix was made in such a way that the oil destroyed the pasty qualities of the flour, the flour absorbed the oil, and he got an oil paste which gave weaker cores than either binder would have given alone. Under certain conditions oil and flour may be used to advantage, but this happened to be one in which they couldn't. There is one obvious fact which is, that for each class of work there is a *best* sand and *best* binder combination which will give the best results. It may take considerable experimental work to determine this, but the saving will generally far exceed the cost for making it.

A few hints as to how the choice of the proper mixture is made may be interesting. First there are probably a certain number of sands available in the particular district; a sieve test should be run on each which will give the relative size of grains or fineness as it is called. The sieves used are generally 20, 40, 60, 80 and 100 meshes to the inch; these are arranged one above another with the coarsest on top. A weighed amount of sand is placed on the uppermost, and the sieves shaken until the various size grains are separated and caught on their corresponding sieves. Then by weighing the amount on each sieve the per cent of grains of that size is obtained. Table I gives the sieve tests on two sands.

Table I.

SIEVE TESTS OF SANDS.

Ottawa Silica.		Delray Bank.	
Mesh.	Per cent.	Mesh.	Per cent.
20	0	20	0
40	72	40	1
60	17	60	2
80	9	80	21
100	1	100	3
100+	1	100+	73
Ottawa silica—Average fineness, 28.			
Delray bank—Average fineness, 88.			

It will be noted from Table I that 72 per cent of the Ottawa silica remained on a 40-mesh sieve while 73 per cent of the Delray passed a 100-mesh. The more uniform the size of grains whether large or small, the better the vent. From the sieve tests and character of work we can determine *what combination of sands would give the proper venting quality.*

If an oil sand core is required we can use one particular oil and run it with these various combinations using the same ratio of oil to sand in each. All sample cores, which are made in the form of a briquette, are baked at the same time, so as to obtain equal conditions of time and temperature. They are then tested in a small machine which gives the tensile strength in pounds per square inch. This data give us *the best mixture of sand for an oil sand core.* Then if there are several oils to choose from we may use this one sand mixture and the same ratio of each of the various oils. Several plates of cores are made from each mixture; all of the plates are put in the oven at the same time and are removed successively after definite intervals of time. This subjects each oil to the same conditions of time and temperature. By testing the tensile strength of these cores we get data for each oil from which we can plot time-strength curves. There is always a maximum in this curve showing a definite baking time corresponding to the greatest strength; when the baking time is longer than this the cores show a loss of strength. The oil which bakes the quickest, gives greatest strength, and falls off least by overbaking is the best oil. Knowing the price of each we can easily determine which to choose.

If a water soluble binder can be used, with or without some oil, we proceed along the same general lines.

Figs. 1 and 2 and Table II give results from actual tests made.

Table II.

COMPARING OIL AND WATER SOLUBLE BINDERS.

Binder.	Sand mixture.	Baking time in minutes. Tensile strength, pounds, per square inch.					
		20	30	40	50	60	70
Oil No. 1.....	½ Rochester and ½ Michigan City	132	138	153	154	156	160
Oil No. 3.....	½ Rochester and ½ Michigan City	59	83	101	108	109	113
½ oil, ½ sulphite liquor	½ Rochester and ½ Michigan City	66	67	68	70	68	65
Sulphite liquor	½ Rochester and ½ Michigan City	22	24	23	23	22	23

Baking temperature plays an important part, and hence, this requires proper control of the ovens. Every binder has a definite baking time and temperature which gives the best results. If not hot enough the cores seem apparently done on the surface, but remain green on the inside; this is a common cause of lost castings and one which may be least suspected. If too hot, part of the binder is volatilized and we lose strength; or the core may be actually burned and have to be discarded. One foundry was using cheap labor at night and losing twice as much in burned or broken cores as it would cost to pay an intelligent foreman to oversee the work. A half hour or more baking after the cores are done may cause the strength to drop as much as 40 per cent. This means that if we control the temperature accurately we can use 40 per cent less binder and yet get as strong a core.

The temperature control can only be effected by using some sort of temperature measuring instrument. This may be a recording or ordinary mercury thermometer, an air thermometer, or any of the various forms of electric pyrometers. The stem of the thermo-couple or the thermometer bulb should be inserted through the wall, and project through 8 inches to 12 inches. We first explore the oven by taking temperatures in various parts and then select the place which will give us a fair average temperature.

The flues from the fire box into the ovens must have adjustable covers over the openings; the pyrometer is observed at definite intervals of time, and these openings either made larger or smaller so that the temperature is kept within certain specified limits. After baking any given core a few times the oven tender will learn just about how long it will take that core

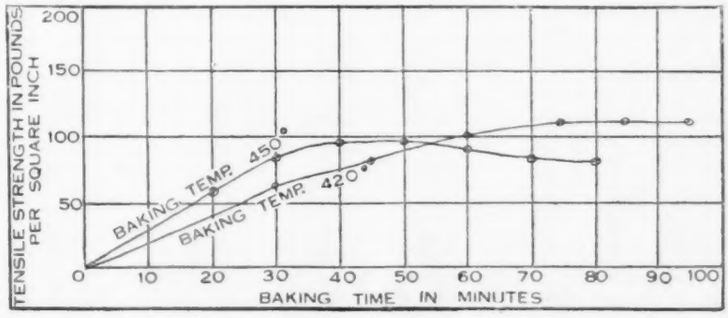


FIG. 3—TIME-STRENGTH CURVES, SHOWING THE EFFECT OF DIFFERENT TEMPERATURES ON THE SAME MIXTURE

to bake, and hence does not need to keep opening and closing the oven to see whether it is done. This results in considerable saving of time in baking.

The time-strength curves in Fig. 3 show the affect of different temperatures on the same mixture.

The rapidity and uniformity of baking will also depend on the circulation in the oven and the amount of free oxygen in the air while these in turn depend on the oven design. In one instance a baking streak could be traced across the middle of the car while the lower corner was always green. By the installation of a forced draft circulation and a slight change in damper regulation the cores came out a beautiful, even color. Another big source of loss is in allowing the ovens to stand idle by improper system of loading and handling; to make up for this requires overtime on the part of oven-tenders and unnecessary expense. Then again, the kind of fuel affects the time and temperature; gas and crude oil both form water vapor in combustion, and the cores will stand a higher temperature without burning than when coke is used, which gives a dry heat.

Mixing

It is actually amazing to consider the lack of attention given to mixing in the majority of core rooms, and yet this one item may mean the loss or saving of many dollars. Mixing by hand is the most expensive, wasteful way imaginable and many castings are lost from improper mixing and assigned to all sorts of other causes. In order to get uniform strength we must have the binder distributed equally through the sand; if not uniform, then hard spots may occur in portions of the core and may produce cracks when the metal contracts on cooling, or a portion of the core may be soft and crumble away easily on handling. Again we do not get the full strength of the binder if not well mixed. A definite measuring system for sand and binder should be used, and the amounts of each worked out so that the right strength of core results. A few examples will illustrate some of the results of poor mixing or improper proportions. One day the foreman in an aluminum foundry ran out of resin and substituted more flour in its place; these cores reached the molding floor the next morning, and loss from cracks jumped 200 per cent; his cores were too hard. He should have known or the superintendent been able to tell him how much additional flour to use.

The superintendent of a certain foundry had a reputation for using a small amount of oil. Before starting investigations the writer was told that the ratio was about 1 to 50. A description of their measuring system is typical of that prevailing in many shops. The man at the mixer would shovel in a certain number of shovelfuls into a batch mixer. If the sand was damp they were large, if dry they were small, but a shovelful was a shovelful to him and he apparently did not worry. The oil was drawn to a supposed depth of three inches in an iron kettle cracked on one side and holding about 10 quarts. Of course, if he was busy and happened to let six inches run out before shutting the spigot, in it went just the same. By the use of a quart measure cup just as the man was about to dump his binder into the mixer, and then a 16-quart pail after the sand was mixed, the actual ratios in use were found to be 1:29, 1:30, 1.33, etc., and the superintendent thought his man was mixing at about 1 to 50. By using a better grade of oil in this plant it was shown that by having a definite measuring system, a ratio of 1 to 100 could be used in most of their work and a saving of about $800 effected for the year. In another foundry, oil at a ratio of about 1:35 was being used when a certain type of water soluble binder would serve equally well.

As to handling of core plates and driers, in most cases the coremaker is made to hunt these out of a pile and get them himself. As a matter of fact a coremaker's time is too valuable for this; by having the various plates sorted as to size, and delivered to him, the coremaker's output may be considerably increased without increased effort on his part. If the sand is delivered from behind the coremaker two disadvantages result, namely either the coremaker himself has to stop operations and wait, or there are three chances to one that several cores are touched and spoiled by the delivery man brushing past them. All of these losses can be avoided by delivering sand, plates and driers from the back of the bench.

Handling Cores

The one object of the core room is to make and deliver cores ready for use. If a raw core is broken it represents the following losses: (1) getting the sand from the storage, (2) putting it through the mixer, (3) cost of binder, (4) delivery to the bench, (5) price paid to the coremaker, (6) placing on the plate, and (7) removal of the sand again. If a baked core is broken it represents not only the preceding items of loss, but also the cost of placing it in the oven, fuel to bake it, and the oven capacity taken up, hence, it is seen that proper handling is of utmost importance.

Various cores require different methods depending on their character; some are so delicate that they must be carried by hand exclusively; others may be put on cars, and still others on carrier. After coming from the oven they must be allowed to cool; a hot core breaks probably 40 per cent more easily than a cold one. They should be packed and handled only in proper boxes.

Each kind of core should have a particular storage place and kept there till used. A striking example of waste was observed recently; all cores could not be baked during the day, so a night gang came on at 5 p. m. Instead of having a night foreman, this gang was all foreign labor; they placed the cores one over another instead of on shelves, and then some of the piles would be accidently pushed over. On each morning for several days the writer noticed a heap representing a loss of at least $15 a night. This would more than pay for a foreman's supervision. All this resulted from a poor system of handling. In this particular core department they were making about 40 per cent more cores on the benches than required for orders simply to make up for their loss in handling and storage. Proper routing, shelves, tote boxes and carrier system takes care of all this trouble.

The Remedy

And now you ask how we are going to remedy the bad conditions existing at present. Simply through a proper system of management and more planning on the part of executives. The work as a whole must be properly divided, definite duties assigned to each individual, and then make him responsible for this part of the work. For instance, after a core leaves the maker his responsibility ceases and the baker is responsible; if the core is broken he must be able to tell why; after it leaves the oven his responsibility ceases and the store clerk is accountable. This is where scientific management comes in, and there are so many factors affecting each particular operation that only a man who has made a special study of the problems should be called upon to introduce these new systems. The men in charge of plants rarely have time to attend to all the routine duties of production and at the same time plan out and introduce the newer methods.

Threaded Fittings Made With Green Sand Cores

How the Equipment is Made for Doing this Work, How it is Operated and the Economies Effected By Its Use

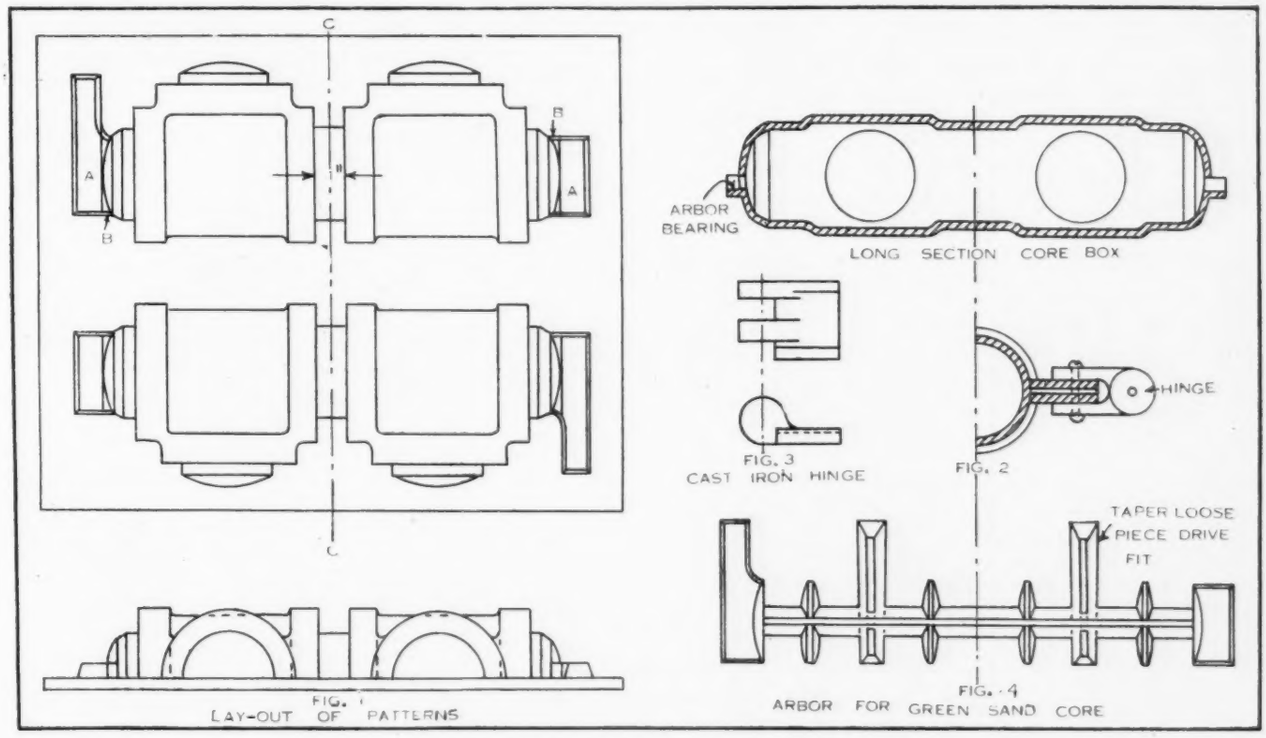
By W J Carew Jr

AS COMPARED with the dry sand method of making threaded cast iron fittings, the green sand process possesses many advantages. However, the latter, in the writer's opinion, is practical only for sizes from 3 to 10 inches in diameter. The most important feature of this green sand work is the fact that the molder or his helper makes the cores. A green sand core, by the method to be described, can be made as quickly as a dry sand core and economies can be effected in coremaking by the adoption of the green sand process.

To make the necessary equipment for green sand cores for a 3 x 3-inch threaded tee, a wood pattern first should be made by laying it out on a board and then building one-half on top of the other, matching the two accurately. The prints should be straight and should be about 1 inch long. As four of these fittings can be made economically in an iron flask on a stripping plate machine, two fittings are made on one core. The two halves of the patterns should be laid out on a well-seasoned board, planed true, and battens should be attached to the back of this board. A 1-inch print should be allowed between the patterns. All points of the layout of the pattern should be taken from the center line, *C*, Fig. 1. The patterns then should be securely fastened, but before doing so, care should be exercised to have them the same height at corresponding points. A trifle above or below the center makes no difference as long as all points are equally affected. The end and branch prints next should be cut and these should be about ¾ inch long. The end prints should be reduced ¼ inch in diameter to provide arbor clearance.

The end pieces, *B*, Fig. 1, next should be made and are attached to the end prints with small, flat-head wood screws. These should not be glued, as they have to be removed and used again for making the core block and the master arbor. The arbor prints, *A*, Fig. 1, are next made and are screwed to the board after locating them in their correct position at the ends of the pattern. These arbor prints are cast separately from the main body of the pattern, as one set of patterns and one machine are employed to make both copes and drags. The arbor prints, *A*, are placed on the pattern when ramming the drag and are removed when making the cope. Small guide pins insure the proper location of the arbor pins and they are not stripped. The pattern should be cast with an allowance of ⅛ inch of stock on the bottom to permit of machining down to one-half the diameter. If the iron patterns can be cast true in fine sand, turning the beads and prints will not be necessary, although many foundries follow this practice. When laying out the patterns on the stripping plate, place them 2 inches apart and make a gate to run the castings from one sprue.

To make the core box patterns, it is necessary to again lay out the master pattern on the original board. Place the arbor prints, *A*, Fig. 1, in their proper position and attach them to the board with screws. Next remove loose pieces, *B*, from the pattern and attach them to *A*. The wood core box is built between these two ends. Assuming that the job has been properly laid out and balanced, cover the block with plaster of Paris and when half dry, work the plaster down to a thickness of 3/16 inch



GREEN SAND CORE MAKING EQUIPMENT

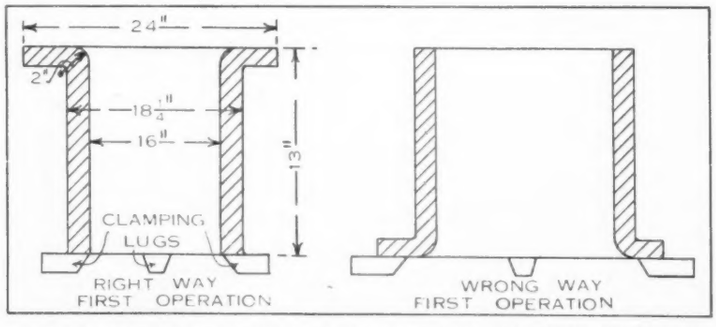
throughout. This forms the body of the drag half of the core box. The prints, *A*, then are removed from the core block and are covered with plaster. Then remove the prints, *A*, from the core block and cover the latter with plaster and work it down to a thickness of 3/16 inch to obtain the core box body. An allowance of 1/16 inch should be made on the joints of both halves of the core box for finishing.

Next build a web around the core box, 5/16 inch thick, as shown in Fig. 2. This web or plate is provided for hinging purposes and should extend upward ⅛ inch on each side of the box. It is apparent that if 1/16 inch has been allowed for finishing the face or joint of the core box, when both halves are reduced one-half the diameter, the webs will be ⅛ inch apart when the box is closed. Cast iron hinges, Fig. 3, which can be made in the shop, are employed. The core box web should be ribbed to prevent breakage where the hinges are attached. One pattern will serve for the entire line of hinges used. Two castings from this pattern will fit into each other and are held together with a ⅜-inch steel pin. The hinges are attached to the core box with ¼-inch screws.

To insure the accurate matching of the core box halves, the ends of each should be filled with plaster of Paris a distance of about 4 inches from the ends and the joints should be struck-off flush. When the plaster is set, the semi-circular pieces should be removed and the opposite halves should be fastened together by cupping-out and the hole at the joint should be filled with thin plaster to serve as a cement. These circular pieces then are placed back into the core box, the other half of the box is set on top of the first half and the hinges are attached.

The arbor and core rod is an important part of this equipment. The arbor, Fig. 4, is made of cast iron. As it should fit accurately into the drag half of the core box, to insure its accurate size, the arbor prints, *A*, Fig. 1, should be screwed to the layout board in the original position and the arbor should be built between them. The arbor wings are placed about 2 inches apart and are ½ inch thick. The wings of the arbor should not extend beyond ⅜ inch from the side of the core box. When setting a green sand core, the molder is guided entirely by the sand-to-sand prints, but the iron arbor ends, which correspond to the imprints in the sand, are the means for supporting the core. No other than a sand-to-sand bearing is necessary on the branch prints as the iron arbor end is made sufficiently wide to counteract any tendency of the core to tilt.

This equipment should be operated by two men, a molder and a helper. The work is done on a piecework basis, good castings only being paid for.



SECTIONAL VIEW OF BRASS CASTINGS, SHOWING THE CLAMPING LUGS PROPERLY AND IMPROPERLY ARRANGED

Machine Design from a Foundryman's Viewpoint

By Dan Cox

A draftsman or patternmaker having a limited knowledge of foundry and machine shop practice can so design a piece of work or make a pattern that it will cause a lot of unnecessary work and loss of time when it is finished in the machine shop. Three recent experiences prompted me to prepare this communication. The first involved a planer job on a large casting with a pocket 27 inches long, 4½ inches deep and 6 inches wide. The machining operation involved the removal of ¼ inch of metal from the bottom of this pocket. The drawings showed no tool clearance and the patternmaker failed to provide for this, yet only 20 inches of machined surface were required. If only one of these castings had to be machined, I never would have registered a kick, but 12 of these were to be finished.

The next job consisted of eight cast steel wheels with hubs 8 inches in diameter and 8 inches long. The drawing specified a hole, 1 15/16 inches in diameter through each hub, the latter having been cast solid because the patternmaker insisted that it is almost impossible to core a clean hole in cast steel. As a result, I was obliged to drill holes in these hubs for the boring tools.

In the accompanying illustration is shown my last machining job and if the machinist were searching for simple work to be finished on the boring mill, I am sure that he would select this piece. Nevertheless, it makes a considerable difference to which end the clamping lugs are attached. During the past 12 months I have finished 37 of these pieces which were cast in brass. The first 10 were made with the lugs attached to the flange face, which is common practice in the pattern shop because it is considered practical for the molder and machinist. As a result, four days were required to finish 10 castings. The clamping lugs were changed to the other end on the remaining 27 castings and these were machined at the rate of four each day. With the lugs on the flange end, this is a simple job of machining, and after boring and turning the body and facing and turning the flange, the lugs must be turned off and the bottom face of the flange finished. To finish this face, the casting is turned over and is held in a four-jaw chuck on the boring mill face plate. As the casting is 13 inches deep, it is almost impossible to hold it and to prevent the turning tool from lifting it out of the jaws of the chuck. With the clamping lugs on the opposite end, the turning and boring is a simple job and rechucking for finishing the end can be accomplished in a short time.

When a large number of castings is to be machined, I would suggest that the draftsman and patternmaker consult the foundryman and machine shop foreman before making the pattern. Because the draftsman or patternmaker is lacking in foundry or machine shop experience is a mighty poor excuse to give to a machinist who is called upon to finish, within a reasonable length of time, castings not provided with tool clearance, cored holes, clamping lugs, etc., that are so essential to the rapid production of work in the modern machine shop.

J. M. Betton, manufacturer of sand blast machinery, New York City, has issued a catalog in Spanish, which is devoted to his line of Drucklieb injector sand blast machines.

A six-page folder issued by the Smooth-On Mfg. Co., Jersey City, N. J., illustrates the applications of iron cement for waterproofing and stopping leaks in concrete.

A Foundry Specializing in Motor Car Castings

How the New Aluminum and Brass Shop of the Willys-Overland Co. is Arranged With Features of Its Equipment and Operation

CASTING production for the automobile trade has developed specialized practice in every branch of foundry work and coupled with the refinements demanded by the motor car manufacturer, the foundryman has been tested to the limit of his ability to meet required specifications. The gray iron parts, without exception, are intricate, and although not more than two decades cover the period from the first introduction of this work to the present time, the changes in automobile foundry practice have been phenomenal. Many shops today are specializing in the manufacture of cylinders and the facilities provided to effect rapid and economical production include every known foundry labor-saving device. Malleable castings also have made big inroads in the automobile field and the specifications adopted have resulted in the revision of practice in many plants. Small parts have added to the tonnage of crucible, converter and open-hearth steel foundries, and here also many improvements in methods were adopted to meet the necessary requirements.

Aluminum Castings

The phenomenal growth of the aluminum castings industry, in recent years, is traceable almost directly to the development of the automobile and motor truck, and so heavy has grown the consumption of this white metal that American reduction plants have been unable to keep pace with the needs. As a result, the importations of aluminum have been steadily increasing, and during the past year a new high record for the consumption of foreign metal undoubtedly has been established. To a considerable extent, efforts were made to substitute malleable for aluminum parts, but inasmuch as the malleable manufacturers have had an opportunity to obtain more desirable work the greater part of this year, the burden of supplying the demand for these light castings has fallen upon the aluminum shops.

While cast aluminum parts are purchased by motor car and truck builders largely in the open market, a number have erected foundries in recent years to provide against any possible interruption in the delivery of their castings. At Toledo, O., the Willys-Overland Co. operates a large automobile plant with a capacity of approximately 200 cars daily. The growth of the business made it imperative to increase the aluminum and brass casting output of the company's small foundry, and a new shop was built, designed and arranged for the manufacture of automobile parts exclusively. The daily output aggregates 25,000 pounds, and the pressure is great for increased production. The

FIG. 1—GENERAL VIEW OF THE WILLYS-OVERLAND CO.'S BRONZE AND ALUMINUM FOUNDRY

FIG. 2—FURNACES FOR MELTING BRASS AND BRONZE

FIG. 3—THE BATTERY OF ALUMINUM MELTING FURNACES

FIG. 4—THE METAL STORAGE, SHOWING THE ALUMINUM PILED LIKE CORDWOOD

FIG. 5—OPENING FROM THE FOUNDRY INTO THE METAL ROOM, SHOWING THE CURVED END OF THE TROLLEY

FIG. 6—TROLLEY SYSTEM IN THE FOUNDRY, SHOWING ONE OF THE TRANSFER BRIDGES

manufacturing problems involved in the building of 200 cars daily are exceedingly complex and any interruption or delay in the sequence of operations immediately is reflected by a curtailment of the output. Regardless of the other causes of delay, it is an axiom that there must be no shortage of cast parts, and to meet these insistent demands, this commodious foundry already is crowded to capacity.

The general arrangement of the foundry is illustrated clearly in Fig. 13. Railroad sidings made necessary the diagonal layout of one side of the plant and here the raw material storages were placed to facilitate the handling of metal and sand. Adjoining the core sand storage is the core shop and the metal storage room

FIG. 7—ONE SECTION OF THE CORE SHOP, SHOWING A BATTERY OF TRUCK CORE OVENS

FIG. 8—ANOTHER VIEW OF THE CORE SHOP, SHOWING A BATTERY OF DRAWER TYPE CORE OVENS

opens into the furnace department. The molten metal is conveyed to the foundry and is distributed to the floors by an I-beam trolley system. Adjoining the molding floor is the cleaning and finishing department. The extreme length of the plant is 296 feet 10 inches, and the extreme width 100 feet. One side of the core shop is 98 feet 8 inches, tapering to a width of 38 feet 4 inches on the opposite side. The length of this department on the diagonal side is 116 feet 5 inches. The molding floor covers an area approximately of 158 x 100 feet, and the cleaning and finishing room is 100 x 40 feet. The furnaces are located in a detached structure, 54 feet square. To provide ample headroom and ventilation the side walls have been carried up to

FIG. 9—CORE TRUCK ON TRANSFER CAR

a height of 20 feet, and the roof trusses span the building, thereby eliminating center columns. The interior of the buildings are painted light gray, and with the side walls consisting of practically a continuous row of windows, excellent illumination is obtained.

An excellent view of the interior of the foundry is shown in Fig. 1. The comparatively small floors is a noteworthy feature and reflects the economy of space made necessary by the constantly increasing demands upon the shop. With the exception of one section devoted to bench molding, practically all of the molds are made on machines. The squeezers are arranged in rows along two walls, while the floor work is made on power roll-over machines arranged back to back. Another section of the molding floor served by the I-beam trolley system is devoted to squeezer and bench molding operations. Aluminum and brass foundry practice, owing to the fact that the molds are poured continuously, permits of the arrangement of smaller floors than is possible in malleable or steel shops where the pouring is intermittent, or in gray iron plants where the molds are cast at the end of the day. This accounts for the seemingly crowded condition of the bench molding floor in the foreground of Fig. 1, and to prevent the accumulation of molds an effort is made to pour-off a floor when four have been made. The roll-over molding machines are arranged back to back with an aisle between two rows and this aisle is commanded by the I-beam trolley to facilitate the distribution of the metal. The mechanical molding equipment consists of 10 Pridmore, power-operated, roll-over molding machines, 12 Tabor roll-over machines, 10 Berkshire squeezers and four Tabor power squeezers. Recently the U. S. Molding Machine Co., Cleveland, installed five power squeezers, one combination jar-ramming and squeezer molding machine and a 38-inch, jar-ramming, roll-over, pattern-drawing machine.

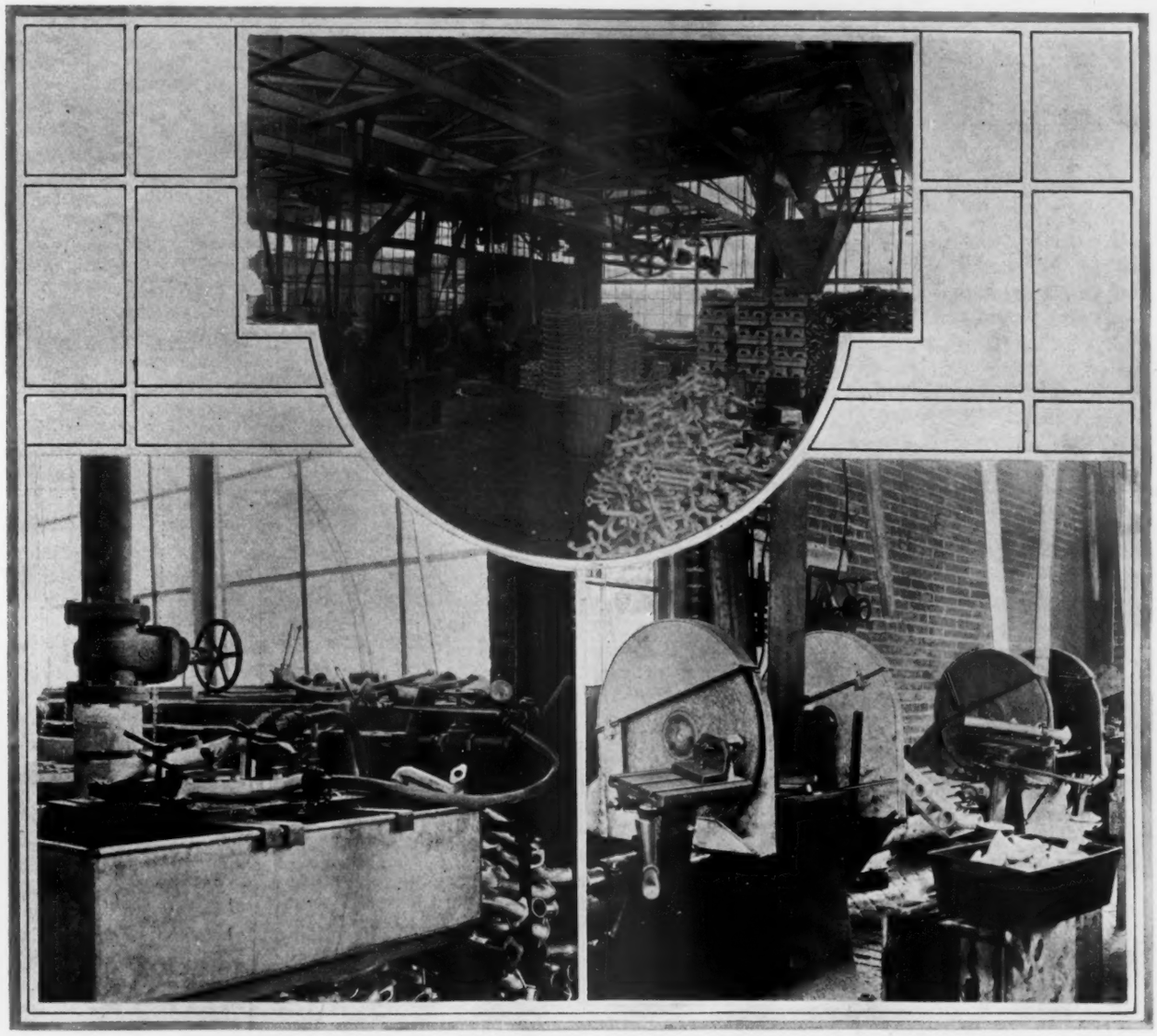


FIG. 10—A VIEW OF ONE SECTION OF THE CLEANING AND FINISHING DEPARTMENT
FIG. 11—THE TESTING BENCH FIG. 12—DISC GRINDERS USED FOR FINISHING

The trolley system, furnished by the J. D. Smith Foundry Supply Co., Cleveland, is utilized for distributing the metal from the furnace room to the molding floors, for conveying castings to the entrance to the cleaning and finishing department and for handling refuse. This system is continuous with loops in the furnace room and at the opposite end of the two main overhead I-beams in the

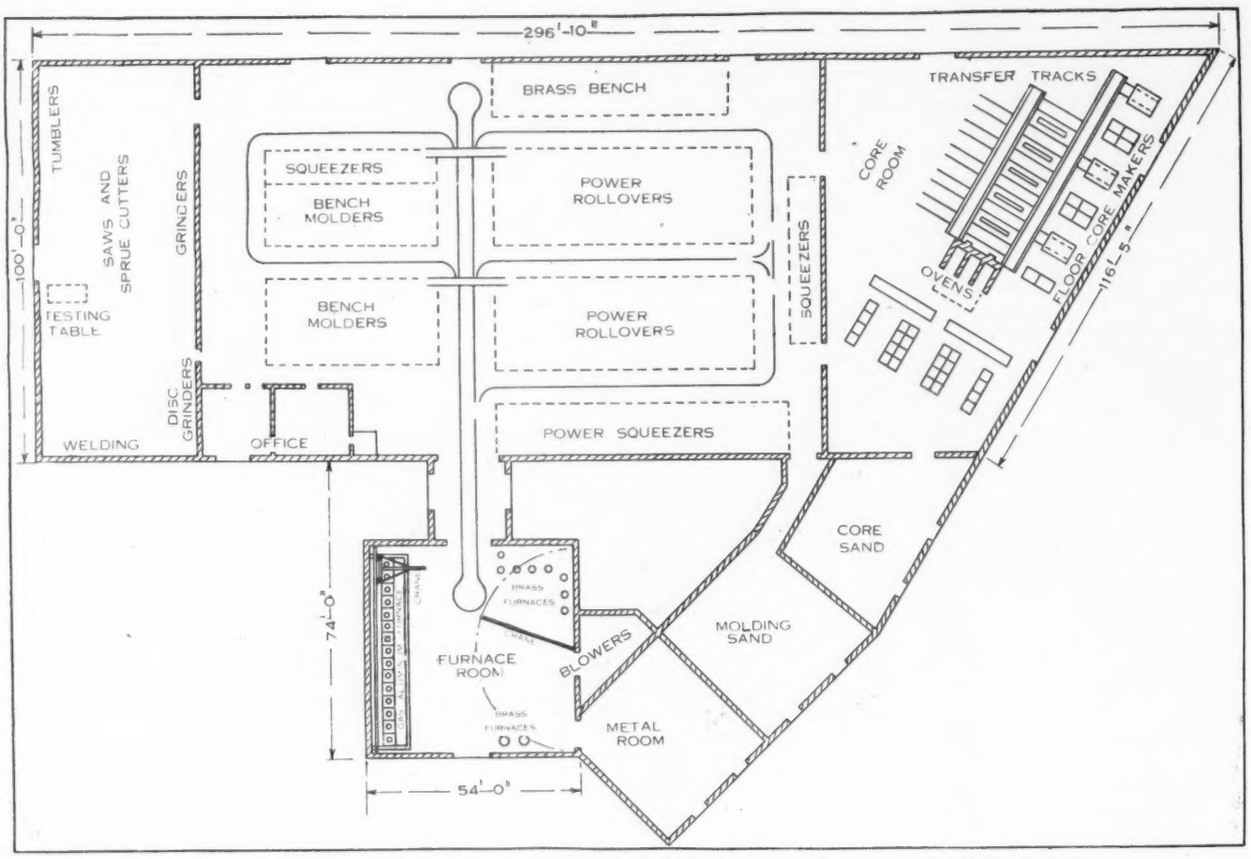


FIG. 13—PLAN VIEW OF THE WILLYS-OVERLAND CO.'S ALUMINUM AND BRASS FOUNDRY

foundry. From these tracks the trolleys are switched by transfer bridges to the tracks commanding the various molding floors. This arrangement is illustrated clearly in Fig. 13, and one of the transfer bridges is shown in Fig. 6. The loop in the metal room is illustrated in Fig. 5, and this, with the loop at the opposite end of the runway from the furnaces across the molding floors, provides for the quick return of the crucibles. The trolley system, which has a capacity of 1,000 pounds, is suspended so as not to interfere with the light on the various floors.

Aluminum is melted in 15 gas-fired furnaces, equipped with cast iron pots, installed by the J. D. Smith Foundry Supply Co. As illustrated in Fig. 3, the furnaces are served by a hand-operated, traveling jib crane for placing and removing the iron pots. At the right of this illustration is shown a pyrometer which is used to measure the temperature of the metal. Chloride of zinc is the only flux used. The brass melting equipment consists of six Fisher gas-fired furnaces illustrated in Fig. 2, one Monarch and one Buckeye, both of the tilting type. The six pit brass furnaces are served by a wall crane equipped with trolley and lever lifter for removing the pots from the furnaces. The total daily output consists of 25,000 pounds of metal, of which 4,000 pounds is brass, 4,000 pounds of hardener and the remainder aluminum. The hardener consists of two parts of aluminum and one part of copper, the two metals being melted in separate pots and poured together to form the hardener. This is added to the pure aluminum in varying percentages depending upon the requirements of the castings being made. The compressed air for operating the furnaces is furnished by an 8-foot Sirocco fan installed by the American Blower Co., which is direct-driven by a 50-horsepower motor. The fan and motor are located in a room adjoining the furnace department.

Original

Daily Report of Foundry Operations

No. 12 Metal _____

Pure Aluminum _____

Scrap Aluminum _____

Copper _____

Lead _____

Tin _____

Zinc _____

Scrap Brass _____

TOTAL _____

Produced

Good Castings _____

Defective Castings _____

Scrap _____

Overmelt _____

Metal Shrinkage _____

TOTAL _____

Per Cent. Shrinkage _____ %

Per Cent. Defective Castings _____ %

Per Cent. of Scrap Produced _____ %

Good Castings per Man _____

Form 619—1000 Set—11-10-11

FIG. 14—DAILY REPORT SHEET

The metal storage is illustrated in Fig. 4. At the time this photograph was made approximately 2,000,000 pounds of aluminum were piled like cord wood in this room. The daily report blank of foundry operations, Fig. 14, contains spaces for entering the amounts of the various metals melted and in addition, the good and defective castings are to be noted as well as the scrap, overmelt, metal shrinkage, with the percentages of shrinkage, defective castings and scrap produced.

The core room oven equipment consists of three rolling drawer and five car ovens of the through type, all fired by artificial gas. As shown in Fig. 13, the bench coremakers work their output through the rolling drawer ovens and thence to the storage space near the molding floor. The floor coremakers load the cars between working points, the cars then

(*Continued on page* 548.)

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

An Aluminum Match-Plate Alloy

Kindly furnish us with an aluminum match-plate alloy, which will shrink approximately 3/16 inch per foot. We make match-plates from an alloy consisting of one third zinc and two thirds aluminum. They are satisfactory until they have been in service two years, when they begin to warp and break, even when not in use. We are now using an alloy consisting of copper, 4 per cent; zinc, 22 per cent, and aluminum, 74 per cent. While this seems satisfac tory, we fear that the percentage of zinc is too high and that our plates may possibly disintegrate after they have been in use. We desire a stable alloy, which will not be too soft, and which will shrink approximately 3/16 inch per foot.

We suggest the use of the No. 12 alloy, which consists of: Copper, 8 pounds; aluminum, 92 pounds. When making this alloy, it is advisable to first make a hardener, consisting of 50 per cent copper and 50 per cent aluminum. The hardener first should be placed in the crucible with a portion of the aluminum charge, and when this settles, the balance of the aluminum can be added.

Porous Brass Castings

We make bushings for automobile repair work, but the castings are porous. We use only scrap brass, chiefly old faucets, and occasionally scrap copper wire. When you refer to melting under charcoal, does it mean that the charcoal is first placed in the bottom of the crucible before charging the metal? We use powdered glass in the bottom of the crucible and this seems to answer our purpose fairly well.

The porosity of your brass bushings is due to the oxidation of the metal while it is being melted and some effort should be made to remove the oxides before the brass is cast. Phosphorus added in the form of phosphor copper is a good deoxidizer, although it is by no means entirely satisfactory for this purpose. We would suggest the use of 2 per cent of 15 per cent phosphor-copper, which should be added to the brass just before its removal from the furnace. In the case of oxidation, however, prevention is better than a cure. This involves careful melting, which necessitates the use of charcoal, and constant supervision over the fires. The charcoal may be added when the metal begins to melt, but it should not be placed at the bottom of the crucible, as it is liable to adhere to the bottom. The charcoal should be placed on top of the melting metal, which it protects from oxidation by acting both as a cover and by generating a reducing gas. Glass serves only as a cover and it is liable to expose the brass to oxidation. If charcoal is difficult to obtain, a piece of hardwood can be placed in the crucible with the charge and when the latter melts, the wood will have been burnt to charcoal, which will cover the molten metal.

Manganese Bronze Mixture

What mixture would you advise for manganese bronze of the following requirements: Tensile strength, 60,000 pounds per square inch; elastic limit, 50 per cent of tensile strength, and elongation, 20 per cent in 2 inches? Also, would you advise the use of lake copper in preference to electrolytic copper in this mixture and is it necessary to alloy any of the constituents of this mixture?

The following mixture will meet your requirements: Copper, 56 pounds; zinc, 42 pounds; iron, 1½ pounds; tin, 1 pound, and 80. per cent ferro-manganese, ½ pound. Either lake or electrolytic copper may be employed. The quality of zinc is the most important item in making a successful mixture. The alloy can be made by first melting a portion of the copper under charcoal until it is hot, then add pulverized ferro-manganese and the iron in the form of thin sheets. When these additions are dissolved add the aluminum and the heat generated will insure the complete alloying of the iron and the manganese. Next follow with the balance of the copper charge and when all of the metal is liquid add the zinc and lastly the tin. If a considerable amount of the alloy is required, a hardening can be made by mixing the proper proportions of manganese and iron with the copper. The hardener is used for making the manganese bronze alloy.

Casting a Large Copper Ladle

We have received an order to cast a large copper ladle about 6 feet in diameter at the top, 4 feet, 6 inches in diameter at the bottom, 5 feet high with a thickness of 3 inches at the bottom, tapering to 1¾ inches at the top. It will require approximately 7,000 pounds of copper and we would like to know how this can be melted in a 38-inch cupola. Also advise us whether pure copper should be used.

Copper occasionally is melted in cupolas and good castings can be made, although the practice is not to be recommended, as sulphur is absorbed from the fuel and oxygen from the blast, resulting in metal that is liable to be wild and difficult to bring back to its normal condition with the aid of a deoxidizer. In melting the copper it is advisable to adhere to the same fuel ratio that you are using for iron and the same practice should be followed, as any change from the usual routine might cause trouble. The copper should be melted as rapidly as possible and should be tapped into clean ladles in the bottom of which the deoxidizer is placed, together with enough charcoal, broken small, to cover the surface of the metal when the ladle is filled. As high electrical conductivity is not of importance in making these castings, the best deoxidizer to use is silicon. A 10 per cent silicon copper should be employed in the proportion of 2 pounds for each 100 pounds of copper.

The copper should be tapped hot from the cupola and should be permitted to flow on the silicon-copper in the bottom of the ladle. However, before being placed in the ladle, the silicon-copper should be broken into small pieces and heated. If it is possible to stir the copper after the ladle is filled, this operation is advisable, but the stirrer should be lime-washed and must not be kept in the molten copper a sufficient length of time to begin to dissolve. For this reason several stirrers should be prepared before the heat is ready. Iron should be carefully excluded from silicon-treated copper as it will produce defective castings. Two per cent

of silicon-copper is the maximum amount generally employed in making copper castings and this percentage is suggested as there is a likelihood of the copper being over-oxidized in the cupola. Before pouring the large castings a test should be made to ascertain whether the metal will be quiet in the mold. For this purpose a small mold should be prepared requiring about 50 pounds of copper and before tapping the copper into the large ladle a sufficient amount should be poured into the small ladle to cast the small mold. The requisite amount of silicon-copper, of course, should be placed in the bottom of a small ladle and the metal should be carefully stirred before pouring. The small mold should be watched carefully as the copper solidifies to note whether the head bulges or shrinks to form a considerable pipe. If the latter is the case, proceed with the casting of the large mold. However, if the head bulges, repeat the experiment with another small mold, using an additional amount of silicon-copper until satisfactory shrinkage occurs. The amount of deoxidizer for the large casting should be governed by what is necessary for producing a satisfactory small casting. It probably will be found that 2 per cent of silicon-copper is all that is required, but this test should be made to be certain of good results.

The large mold should be made in dry sand or loam and should be coated with black lead, the same as when molding for iron castings. The copper should be poured at the lowest possible temperature and the mold should be provided with heavy feeders approximately the same as for steel. The copper should be handled quickly when out of the furnace, but need not be poured at a high temperature. It is not necessary to use pure copper.

Slag in Brass Bushings

We would like to have your opinion regarding the cause of slag in automobile bushings. The bushings we cast are flanged and are made of the following mixture: Copper, 84 per cent; tin, 6 per cent; lead, 10 per cent, and zinc, ¼ per cent. Unfortunately, the mixture cannot be changed. The trouble we are experiencing is intermittent. We melt in oil-fired furnaces, using charcoal and salt as a cover and phosphorus as a deoxidizer. The copper is melted first, the pot is drawn and skimmed clean, after which the other metals are charged. We have tried adding the softer metals before drawing the crucible and never experienced any trouble from lead segregation.

Slag in brass castings usually can be attributed to the use of phosphorus. The slag is held in suspension and continues to rise to the surface until the alloy is almost at the point of solidification. The best remedy, therefore, is cool and quick pouring. In this instance, however, your difficulty undoubtedly is due to oxidation and the fact that it occurs only occasionally would indicate that it is caused by some irregularity of operation. This undoubtedly can be traced to the furnaces, the metal being oxidized to a greater extent at one time than another. We suggest that a blanket of slag be kept on the copper while it is melting and for this purpose a mixture of plaster of Paris and soda ash should be employed consisting of four parts of the former to one of the latter.

Splitting of Bronze Plates

While machining a cast bronze plate recently, a small sliver became detached and we are at a loss to account for this peculiar occurrence.

It is not unusual for thin bronze plates to split after being machined, and this phenomenon is attributed to crystallization. In this case, however, the sliver was caused more by oxidation than crystallization, although the latter was a contributing factor. To make clearer this peculiar occurrence, it is advisable to first explain how a bronze plate is split by crystallization. When a plate of this kind is poured, the metal in contact with the sand sets first and forms a shell, inside of which the molten metal is contained. The heat from the latter cannot escape except by radiation through the walls of the shell and therefore it cools comparatively slowly, a condition favorable to the formation of large metallic crystals. As these crystals are formed, they attach themselves to the inside of the shell in the cope, drag and sides of the mold, growing in all directions toward the center of the casting. Inasmuch as the metal, when solidified, occupies less space than when liquid, a void is left in the center of the plate, which may vary on a machined section from a thin line with forked ends to quite a gap. When such a plate is machined so that the sides are cut away, it frequently happens that it will split in half or can be split easily with a chisel.

This phenomenon is due entirely to the formation of the shell, which lacks the normal shrinkage and as there has to be shrinkage somewhere, it occurs in the center of the casting. In the case under consideration the metal was heavily oxidized and the oxide segregated in patches. The same conditions of solidification obtained as in the case outlined, except that the metal solidified more rapidly in one half of the mold than in the other, probably in the drag, and the oxide rose through the metal in the mold until it encountered the thin shell in the cope. As it could rise no further, the oxide remained in the casting and formed a parting, enabling the piece to be broken out as a sliver by the tool. In the case of a heavy casting, the dross would have formed dirt in the upper part of the mold. The remedy is to use some effective deoxidizer to clean the metal, which should be stirred thoroughly, well skimmed and poured hot.

How to Utilize Brass Turnings

We are manufacturing brass castings, which are tested at 180 to 200 pounds water pressure and occasionally these castings leak and are rejected. We are compelled to use a large amount of red brass turnings from automatic machines and as our shop is small, we are not in position to cast these turnings into ingots. A large amount of these turnings now have accumulated and we would like to know whether these should be cast into ingots and used in place of zinc or whether it is advisable to sell them. If possible, we would like to have a mixture in which these turnings can be used, so as to insure solid castings. Our best results have been obtained with a mixture consisting of 80 pounds of copper, 8 pounds of zinc, 4 pounds of tin and 4 pounds of lead. We tried a mixture consisting of 60 pounds of copper, 33 pounds of yellow brass turnings, 4 pounds of lead, 2½ pounds of tin and ¼ pound of manganese-copper, but this did not prove satisfactory. Can satisfactory castings be produced by the use of turnings alone?

We suggest a trial of the following mixture: Copper, 66 pounds; red brass turnings, 23 pounds; tin, 4 pounds, and lead, 3½ pounds. First melt the copper, using a small amount of salt and sufficient charcoal to form a cover about ½ inch on top of the molten metal. When the copper is hot, add the turnings gradually, being careful not to chill the melted copper. When the turnings are dissolved, bring the metal to the casting temperature, add the tin and lead, stir thoroughly and cast. The turnings also can be used along for small yellow brass castings, but not for high pressure work. For this reason it might be advisable to dispose of your accumulation of turnings and any surplus over what is required for the mixture given.

A Compilation of Electro-Plating Hints

By Seymour W Rowsbar

IN MANY industrial plants where electroplating is one of the operations performed on the manufactured product, the foreman of the plating department frequently is called upon to do various tasks which are not ordinarily included in his list of accomplishments.

If he is endowed with a moderate amount of mechanical ingenuity or a faculty to put to use simple ideas with studious care, he invariably can prove that an electroplater may also become an emergency expert. Possibly the greatest obstacle he encounters in such cases is the tendency of the human mind to forget just the idea desired, although he may have felt quite familiar with it at some previous time.

The Value of Notes

The foreman may have some unusual difficulty with a solution or the current. Eventually he corrects the conditions and with the utmost confidence in his memory he neglects to make a note of the cause and effect of the trouble, or the remedy found to be effective. After perhaps a considerable period he is confronted with the same difficulty or wishes to advise some one who is having a similar experience, but now he is not sure how he did the job before, and owing to the fact that he has neglected the *why* of his electroplating education, he is unable to proceed with the degree of certainty which would otherwise characterize his labors, or to impart the information intelligently. This naturally is embarrassing and entails loss of time and possibly a waste of material. Believing that a brief mention of some of these side lights will be appreciated by readers of THE FOUNDRY, we here present a few. Others will appear in future issues.

When heavily plating automobile threaded parts or bolts, studs, etc., of any mechanical device required to fit accurately and assemble easily, the metallic deposit on the threads or ball races of bearings causes more or less annoyance, especially in the final assembling of the machine. The threads and ball races of such small parts may be kept free from the electro-deposits by forming a piece of sheet iron or aluminum in the shape of a box without ends, the sides of which are rectangular parallelograms. The length of this holder may be made to suit the length of anode employed and the inside diameter of the box is made of sufficient width to accommodate the portion of the article to be protected. Holes of proper size are drilled in the two opposite faces and the bolts or studs inserted. Only the exposed portions will receive an appreciable coating. This holder is easily filled and emptied and does not rapidly acquire a heavy deposit of metal. If black sheet iron is used, the accumulation will easily strip off after a few immersions, while with aluminum the deposit may be removed after each run, if desired.

Imitation Damascus Steel

The production of imitation Damascus steel, while simple, has caused many platers great concern when requested to produce the finish. The original Damascus steel finish was obtained by treating articles of both iron and steel, welded together with acids, the acid causing a coating of carbon to form on the steel surface while the iron remained unaffected; thus, a variegated or wavy, watered steel effect was obtained. This finish is now becoming popular for various lines of lacquered steel trimmings and may be produced as follows: The simple watered finish is obtained by covering the article with a solution of copper sulphate, 1 ounce; tincture of iron, 2 ounces; nitric acid, 1 ounce; spirits of wine, 1½ ounces and spirits of nitrous ether, 1½ ounces, dissolved in one gallon of water. One application produces a brown discoloration and when the surface dries, the application should be repeated until a black is obtained or the shade desired, after which the articles are washed with strong, hot carbonate of soda solution and finished on a fine steel scratch brush and lacquered. To produce figured work or floral designs on the metal, a stencil is used and the solution is painted on and allowed to dry, care being taken not to apply the brush too plentifully charged. Intricate and beautiful designs may thus be transferred to the metal which may be finished to harmonize with the non-metallic portions of the product it is intended to ornament.

Carbon Black

A carbon black on steel is often required by manufacturers of builders' hardware and is used on interior limousine fittings in the automobile trade, also by makers of optical goods. A durable and simple dead black is produced by polishing the article and coating with equal parts of linseed oil and engine oil in which mixture a small quantity of lamp black has been well stirred; then burn off over a charcoal fire. Repeat the process if not sufficiently black.

When refinishing zinc goods or work consisting of a large percentage of zinc, difficulty is liable to be experienced in cleaning and plating. The lacquer should first be removed with alcohol or by immersion in a solution of some non-tarnishing cleaner which is kept boiling. Such solutions do not attack the metal as would be the case with strong caustics. After washing quickly immerse in a solution of nitric acid and oil of vitriol diluted with water. Such immersion may require repetition. The necessary polishing is then performed and the work cleaned in the cleaning

solution previously mentioned. All filigree work or indented backgrounds should be especially well-brushed out. If a silver finish is required, the zinc is coppered in an electroplating solution made up as follows: Dissolve in 1 gallon of cold water 4 ounces of potassium cyanide; when all is dissolved, add 4 ounces of carbonate of soda and 3 ounces of acetate of copper, stirring well, and allow the solution to cool. When cool and ready for use, add 1½ ounces of liquid ammonia. The solution works best at about 120 degrees Fahr. After coppering, buff, cleanse again in the mild cleaning solution and immerse quickly in a blue dip composed of 2 ounces of potassium cyanide and ¼ ounce yellow oxide of mercury dissolved in 1 gallon of water; then rinse and silver.

Refinishing Gilt Goods

To refinish ormolu gilt goods which consist of two or more separable parts, it is good policy to take them apart and polish the high lights, using a good, hard rouge on a large size buff at a speed of at least 2,800 revolutions per minute. Clean the grease from the work by passing through hot potash and swabbing the surface with a cotton potash swab. The cleaning should be performed as expeditiously as possible to insure the best results. Next rinse thoroughly with cold, running water, followed by dipping in a hot soap solution with a small content of ammonia. Inspect the work for small particles of rouge and perfect the cleaning with a cotton swab kept for this final cleaning, then rinse and immerse in a moderately strong cyanide dip. Rinse again and gild in a hot solution consisting of 2 pennyweights of gold to each gallon, with a little free cyanide. The operator next takes the cathode in one hand and the anode, which is preferably of platinum and of liberal size, in the other hand; he immerses the cathode, then the anode, keeping both constantly in motion and the anode equi-distant from all portions of the cathode, by a semi-circular movement. A rich-colored film of gold will be obtained in a few seconds; then rinse in cold water, followed by hot water and dry with good, clean, boxwood sawdust, finishing with a soft, clean cloth; lacquer with either gold-colored or transparent lacquer.

In the production of old brass finishes, try using ordinary emery paste. The paste may be made of any grade of emery found to be most suitable, but the grades which are generally used are the emery flour and No. 120. Use a slow running bristle brush at from 250 to 400 revolutions per minute. The paste does not fly from the wheel and is a rapid cutter. It is cheap and a material usually kept in stock, while the results obtained are all that can be desired. The paste is easily removed from the work with potash.

If difficulty is experienced with the lining of tanks containing silver solution, the following method will avoid future trouble: Make a lining of Portland cement, 1 part; fine sand, 2 parts, and face off with a pure Portland cement. Make the lining ½ inch to ¾ inch thick. No waterproofing is necessary and if the lining is properly placed it will endure for 25 years or longer. A 300-gallon tank may be lined with this material in a few hours. Asphaltum cannot be compared with this mixture for silver baths.

Scores of platers have lost their temper trying to produce a first class electro-deposit of brass upon antimonial lead objects. They frequently condemn the metal and are skeptical as to the possibility of such coatings. By depositing a coating of copper on the lead in a hot cyanide copper bath, using a rather weak current at not much more than 1½ to 2 volts and then transferring to the brass bath, the operation is made quite simple. The trouble invariably is caused by the current employed for brassing, which usually is too strong for such work. The preliminary cleaning must be carefully done, as much depends on the first flash of metal and the condition of the surface to which it is expected to adhere.

Depositing Gold

When depositing gold, much time and worry may be saved by remembering that almost any color may be obtained from one solution if the current strength and temperature of the bath are varied according to requirements. Gold solutions usually deposit about as follows: When hot (180 degrees Fahr.) the color is red with weak current, while with a strong current a rose tint is produced. Cold solutions and a weak current yield a pale yellow and a strong current causes a red tint. A solution at about 120 degrees Fahr. gives a fine gilding color, while for the green, gold color obtained by the use of both silver and gold, the bath is used cold, as hot baths yield reddish tints even when arsenic is used to produce the darker shades.

There are scores of formulas for black finishes, but the really good are few in number. The following is not new, but has been proven capable of producing results superior to the average art black: Make a paste of 12 ounces white arsenic and a little water, then dissolve 5 ounces of C. P. caustic potash and add the arsenic; heat the solution and boil until the caustic soda has dissolved the greater portion of the arsenic; constant stirring will hasten the solution; then allow to cool and add enough water to make up the amount lost by evaporation. The surplus arsenic is not harmful in the bath and is allowed to remain settled in the bottom of the tank. Use plenty of sheet iron or steel anodes and 3 to 3½ volts with the bath cold or slightly warm. A 10 or 15-minute deposit is hard and durable. The deposit also has a fine color, slightly differing from the usual black and forms quickly, while the maintenance of the bath costs practically nothing. Heavy deposits are to be avoided, as they are liable to flake, and color with a soft buff and rouge. The solution should stand about 10 degrees Baume when normal, and as the solution contains no cyanide, the deposit does not fade rapidly, but should be lacquered for the best finish.

Soldering Paste

Recently while making some changes in bus-bars and tank connections, difficulty was experienced in soldering the connections, owing to size and location of the conductors. The following soldering paste is recommended and tried and we found its use simplified the operation greatly. Into ½ ounce of hydrochloric acid place all the sheet zinc the acid will dissolve, then thoroughly mix this solution with ½ pound of vaseline. This mixture used as a paste will enable a novice to solder large conductors easily by using a common blow torch. The joints are left clean and the sweating of the parts is quickly accomplished without the usual gumming and burning which characterizes the operation when ordinary flux is employed.

A man employed in the capacity of foreman of a plating plant recently told the writer that a nickel solution was too simple to be interesting. Later we were informed by his employer that this foreman used a barrel of nickel sulphate (about 300 pounds) in one year to maintain 100 gallons of nickel solution. Another man operating 5,300 gallons of nickel solution for a number of years, without the addition of a metallic nickel salt, when told he must be an expert, remarked, "No, indeed, I know very little about a nickel solution." From this brief mention of two opposite cases, a valuable lesson may be learned. The second man believes in a large anode surface, as it is cheaper than to add salts continually. A nickel solution with a large anode surface is much easier managed and gives better results. Platers who complain that the metallic strength of a nickel bath cannot be maintained normal without the addition of nickel salts are

(*Continued on page* 553.)

A Novel Combination Furnace for Making Steel

Vessel for Employing the Side-Blow, Open-Hearth and Electric Processes, But Either of the Latter Two May Be Eliminated for Finishing

AN EXCEEDINGLY ingenious furnace for producing steel, which combines the side-blow converter, open-hearth and electric processes, designed by E. Cooper Wills, general superintendent and constructing engineer, has been installed in the plant of the Morris Iron & Steel Co., Frederick, Md. The furnace is so constructed that steel can be made by the three processes combined or by the side-blow converter or the electric. As shown in the accompanying illustrations, the furnace is cylindrical in form, 14 feet long and 8 feet 10 inches in diameter. The entire melting medium is so mounted that it may be tilted or rolled backward and forward to facilitate the converter steel-making process and also for tapping the metal from the furnace. The charging and pouring side is illustrated in Fig. 1, which also shows the three-horsepower electric motor that operates the tilting mechanism, consisting of triple screw gearing. It will be noted that a ladle pit is provided in front of the furnace, and to enable the charging and pouring trough to swing through an arc during the various furnace manipulations a rectangular pit leads into the ladle pit in the foreground. The metal first is melted in a cupola shown at the left and is charged into the furnace through the same trough through which the steel is tapped.

The Furnace

The opposite side of the furnace is illustrated in Fig. 2. The dome, *A*, through which gas is admitted when the furnace is operated on the open-hearth principle, also serves as the nose or spout while the furnace is operating as a side-blow converter. The blast box and tuyeres are illustrated at *B*, *C* is the downtake pipe and *D* is the blast pipe. The stack is shown at the right. The furnace chamber rolls on V-shaped plates. The downtake pipe, *C*, is brick-lined and is bolted to the furnace. This pipe is of a radius which maintains it constantly central in the gland connection when the furnace is tilted or rolled backward and forward during the steel-making operations. Ports are located on either side of the hearth section on a level with the surface of the metal, and the gases, after passing through reversing valves, are led to the stack. On each end of the furnace opposite the ports are openings through which scrap and other raw materials are charged and each end of the furnace is provided with a slag pocket.

The wind box is provided with a valve which shuts off the air from the tuyeres while the furnace is being operated as an open-hearth. This prevents the gas from working through the tuyeres to the blower and aids in centralizing the combustion of the gas on or near the surface of the metal. The gas is introduced through a door on top of the dome and when the furnace is being operated as an open-hearth, the dome section serves as a combustion chamber. In the accompanying illustration this door is shown raised, being in this position during the side-blow converter operation. However, when the furnace is to be operated as an open-hearth, this door is lowered and the gas is introduced through it to facilitate the further refining operation. The reversing valves, which are of brick construction, are 14 inches wide, 16 inches long and 4 inches

FIG. 1—CHARGING AND POURING SIDE OF THE WILLS COMBINATION SIDE-BLOW, OPEN-HEARTH AND ELECTRIC FURNACE

thick. They are placed horizontally in the furnace flues and are connected to the reversing mechanism by steel bands. When the steel is to be finished by the electric process, all air is excluded and the doors on the dome, the ports and the tuyeres are closed. Two sets of electrodes then are introduced into the bath, which effect the refining operation. The tuyeres point downwardly and are set at an angle of 10 degrees from the horizontal. The hearth is so constructed that when air at approximately three pounds pressure is introduced, the metal at the point of contact with the air is raised to a high temperature and is driven across the hearth to the opposite side. This imparts a rolling action to the metal in the furnace and facilitates the removal of impurities. As the side-blow converter process costs less per ton of steel than the open-hearth, it is employed to prepare the steel for its final refining by the open-hearth or electric processes.

It is claimed that test bars shaken out of the sand without annealing can be bent without fracture 1½ times through a circle less in diameter than the width of the bar. Steel scrap can be employed in amounts varying from 20 to 80 per cent of each charge. The first heat recently made consisted of 75 per cent of pig iron and 25 per cent of steel scrap. The pig iron analyzed as follows: Silicon, 1.87 per cent; phosphorus, 0.029 per cent; sulphur, 0.024 per cent, graphitic carbon, 3.55 per cent; combined carbon, 0.59 per cent; copper, 0.69 per cent, and manganese, 0.08 per cent. The cupola charge consisted of 6,150 pounds of metal and the steel tapped from the furnace totaled 5,560 pounds. The only alloy additions consisted of 50 pounds of ferro-manganese. A test bar cast from this heat had the following physical properties: Elastic limit, 44,470 pounds per square inch; ultimate strain, 65,240 pounds per square inch; elongation in 2 inches, 0.74 inch; elongation per cent of length, 37; percentage of reduction in area, 64.40. Steel from this heat contained carbon, 0.12 per cent.

The furnace also can be used for making malleable iron. When the carbon in the metal is practically all in the combined state and after the greater portion of the silicon has been removed, the metal is similar to malleable, and when annealed, it possesses all of the desirable properties of high grade malleable iron. It is claimed that various alloy steels can be made in this furnace by the addition of manganese, nickel, tungsten, etc., which should be charged in the molten state.

When operating the furnace, gas is admitted through the cover in the dome and the iron from the cupola is charged through the pouring trough. The gas then is shut off and air is admitted through the tuyeres at a pressure of from 3 to 3½ pounds for a period of approximately 20 minutes to complete the conversion of the iron into steel by the side-blow converter process. The tuyeres then are closed and the steel is further refined either by the open-hearth or electric process. Blast is furnished by a Paxson-Green blower operated by a 75-horsepower General Electric motor. At a recent meeting of the Philadelphia Foundrymen's Association, Mr. Wills described his process and exhibited numerous steel castings and bent and twisted test bars made from this steel which had not been subjected to annealing.

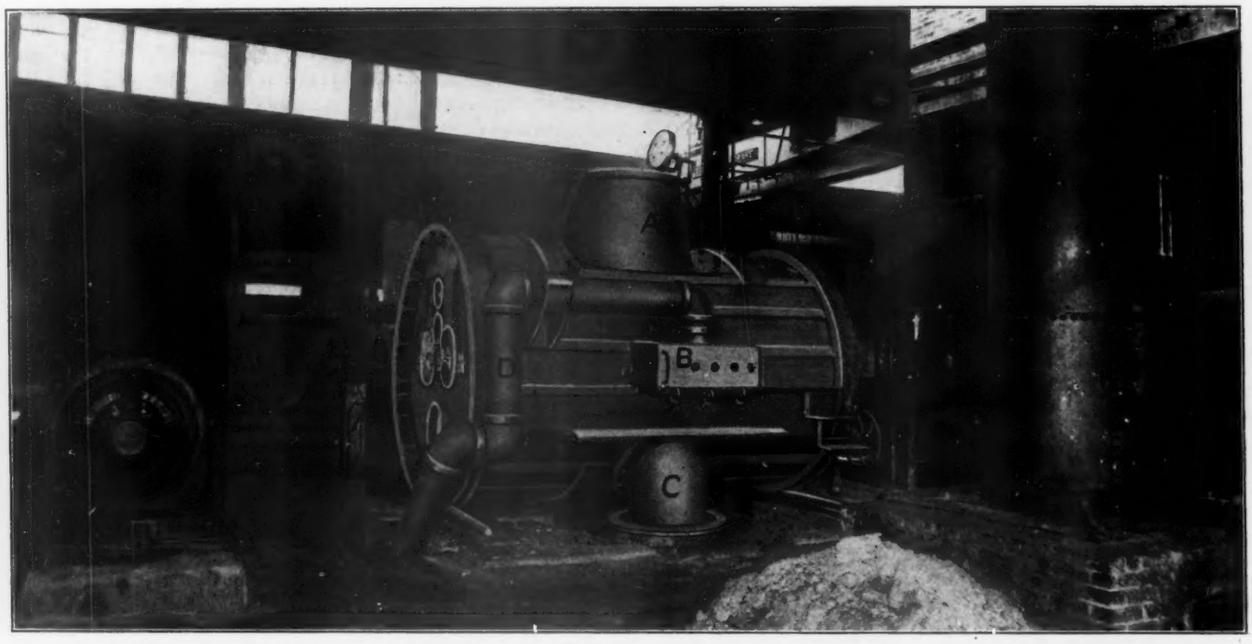


FIG. 2—OPPOSITE SIDE OF THE WILLS FURNACE, SHOWING THE WIND BOX AND TUYERES, DOWNTAKE AND BLAST PIPE

A Foundry Specializing in Motor Car Castings

(*Continued from page* 542.)

being transferred to any oven available, and after baking, pass out the opposite ends of the ovens to the transfer car, to be placed on any track desired. Different views of the core room are illustrated in Figs. 7, 8 and 9. Fig. 9 shows the core storage with its tracks for loaded cars that have been discharged from the ovens after the cores have been baked. The transfer car track extends the length of one side of the ovens and a car of cores from any oven can be transferred to any available storage track. The rolling drawer ovens are shown in Fig. 8 and the entry side of the car ovens with a transfer track is illustrated in Fig. 7. The core sand storage and mixing room opens into the core department, being equipped with a Standard Sand & Machine sand mixer and two pneumatic shakers.

By the use of the disc grinder, many operations heretofore performed in the machine shop, now are being accomplished in the foundry cleaning department. Two of the three Gardner double disc grinders installed are shown in Fig. 12. Practically all of the aluminum castings, within the capacity of these machines, are surfaced on these grinders and great economies have been effected as compared with the usual machine shop operations. The grinders are provided with tilting tables and jigs are used for holding the work. A view of one section of the cleaning room is shown in Fig. 10. All of the equipment is belt-driven from two motor-operated shafts. For cutting gates and sprues, two J. D. Smith sprue cutters and two band saws have been provided and

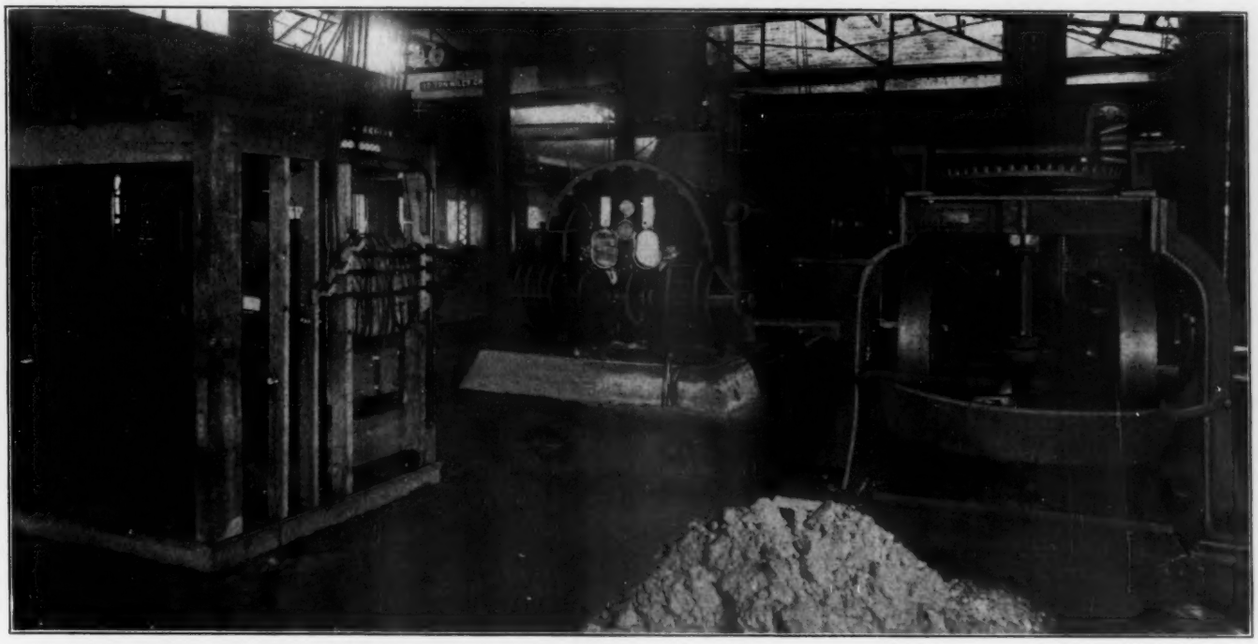


FIG. 3—END VIEW OF THE WILLS COMBINATION FURNACE, WHICH SHOWS THE SWITCHBOARD STAND AT THE LEFT FOR CONTROLLING THE ELECTRODES

ten double emery grinders are grouped at one side of the room. For cleaning brass castings, two water tumblers have been installed. Two benches for testing manifolds and oil pans are illustrated in Fig. 11. These castings are subjected to 4 to 5 pounds water pressure, and if leaks occur the parts are made watertight with aluminum solder. If leaks still persist after soldering, the casting is rejected.

A section of the dust arrester, furnished by the Knickerbocker Co., Jackson, Mich., is shown in Fig. 10. The grindings are exhausted from the disc and emery grinders through hoods and are carried to the arrester through galvanized iron pipes. As the brass grindings are heavier than the aluminum, they are automatically separated from the latter and are not carried over into the arrester, thereby eliminating the necessity of separating these materials after being discharged. A. P. Slater, formerly affiliated with the Aluminum Castings Co., is superintendent of the Willys-Overland foundry.

A Flux for Gray Iron

The Markova Mfg. Co., 350 Cedar street, St. Paul, Minn., is manufacturing an alloy designed to soften, strengthen and purify gray iron. This alloy is placed in the bottom of the ladle, one ounce being sufficient to purify 500 pounds of iron. The molten iron, when tapped from the cupola, runs onto the flux in the bottom of the ladle. This alloy should not be placed in the ladle after it is filled with iron, owing to the fact that it cannot perform its work properly when thus applied. It is claimed that by the use of this alloy a much higher percentage of scrap can be used in the mixtures. As high as 90 per cent of all kinds of scrap, including steel and semi-steel, can be used and a soft iron, it is claimed, will be assured if this alloy is employed. This alloy is furnished in diamond-shaped cakes weighing one ounce each.

McLain's System

A booklet containing a synopsis of McLain's System, Goldsmith building, Milwaukee, recently has been issued and it briefly outlines the subjects discussed in the various lessons and contains a number of testimonial letters from students in foundry practice who have benefited from this correspondence course. The first lesson discusses the composition of iron and analyzes the action of the various elements, the use of scrap, etc. The second lesson teaches how to make mixtures by analysis, while the third lesson considers general foundry practice. The fourth lesson is devoted to chilled castings and lessons five and six consider cupola practice and semi-steel, respectively. The system is arranged in 12 parts with a question paper with each section. In addition to this course, personal advice is furnished students, covering every phase of foundry work and all of the difficulties which they may encounter in the daily operation of their plants.

Rat Tails in Stove Covers

By W. J. Keep

Question.—We are troubled with rat-tailing. We have tried suggestions contained in an article published in THE FOUNDRY in June, 1911, but after the castings are polished, these defects seem to develop. We have decided that it is caused by the iron which we are using. Our castings contain nearly 3 per cent silicon, 0.5 per cent phosphorus and 0.6 per cent manganese.

Answer.—To prevent rat tails, use coarse sand. Your trouble is in too high silicon, causing an open grain on the surface when the rib is on the under side. Use outside stove scrap or purchase a No. 4 iron with silicon as low as 1.75 per cent, then use enough of this to reduce the silicon to 2.75 per cent.

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Trade Outlook

OPERATIONS in gray iron, steel and aluminum shops have been slightly curtailed, although the malleable foundries have considerable tonnage ahead and the melt in all sections of the country is practically normal. The decline in the demand for steel products has not been reflected in the foundry trade in like proportion and with the consumption of pig iron as the barometer, casting requirements are being maintained at a comparatively steady level. Stocks in the yards of consumers are low, and shipments of pig iron to casting plants invariably are for immediate requirements. Present adverse business conditions, in large measure, are attributed to the tariff and pending currency legislation. Lower prices for all pig metals are anticipated, although the pig iron market today represents cost of manufacture and a further decline can hardly be expected. Quotations in the east will not permit of the sale of foreign pig iron in competition with domestic and it is the prevailing belief that relief from this source has been greatly over-estimated by foundrymen located at seaboard points as well as at inland centers. With trade conditions basically sound, the recovery from the present lull should be rapid, particularly after it is realized that the readjustment following the reduced tariff has not effected a great change in domestic commerce. In the leading centers, No. 2 foundry iron is quoted as follows: Pittsburgh, $14.65 to $14.90; Cleveland, $15; Cincinnati, northern, $14.70 to $15.20; Philadelphia, $15.25 to $15.50; Birmingham, $11.50, and Chicago, $15. Lake Superior charcoal is unchanged at $15.50, Chicago, and malleable is quoted at $14.90, Pittsburgh, and $15, Chicago.

Chicago Next Year

IT IS gratifying to note that the conventions of the allied foundrymen's associations and the exhibition of foundry equipment and supplies will be held concurrently next year as heretofore. It was believed that a return to spring meetings on the part of the American Foundrymen's Association and the American Institute of Metals might obviate the possibility of holding a show at the time of these gatherings in 1914, but the selection of the second week in September insures a sufficient lapse of time since the last exhibit to enable manufacturers to design new types of tools and to improve existing machines. All of the builders of labor-saving equipment strive for novelty as a feature of at least a part of the product which they display, and it can be predicted that the exposition, which again will be held in Chicago, will not be lacking in this respect. In 1915 Founders' Week undoubtedly will be celebrated at some point in the east. Both New York City and Philadelphia have large halls for exhibition purposes, although the Quaker City is preferred as the facilities available there surpass anything offered elsewhere on the other side of the Alleghenies. An international congress of foundrymen has been suggested for 1915, to be held concurrent with the annual meetings of the various foundrymen's societies, and, although the project is still in its early stages, the support of a majority of foreign organizations of casting manufacturers already is assured. A congress of international scope would add considerably to the interest and value of the 1915 meeting, and the attendance of a large number of foundrymen from abroad, who will come to this country for the Panama Exposition, is assured.

How Molders Can Be Safeguarded From Injury

Results of an Investigation of Accidents in Casting Plants, With Recommendations for the Use of Goggles, Congress Shoes and Leggings

TO REDUCE the hazard of employment in foundries, the National Founders' Association, through its Committee on Safety and Sanitation, of which M. W. Alexander is chairman, has made an interesting investigation of the principal causes of injuries to foundry employes. Letters were sent to all of the members of this organization and reports of 2,009 accidents were received from 108 shops in a period of 10 months, January to November, this year. A close study of these reports was made to ascertain the most prevalent causes of accidents in casting plants and it was found that carelessness on the part of both employers and employes constituted 85 per cent of the total. Unavoidable accidents aggregated only 9 per cent, while 29 per cent easily could have been prevented by the adoption of the proper safety devices. Sixty-two per cent were caused by the lack of care on the part of the injured employes or others working with them and 23½ per cent resulted from handling molten metal. Injuries to eyes other than those resulting from the handling of molten metal constituted 12½ per cent and 25½ per cent resulted from the handling of materials. Nine per cent of the accidents were caused by handling materials with cranes.

Accidents Investigated

It frequently has been stated that the time of day has a direct bearing on the number of accidents, as it generally is believed that more injuries result early in the morning and during the closing hours of the day than at any other periods. Of the 2,009 accidents reported, only 7 per cent occurred between the hours of eight and nine in the morning and 13 per cent between four and five p. m. In making this analysis, the day of the week was given no consideration, although pouring-off was considered to be an element of danger. Of the total number of injuries, 86 per cent resulted in less than two weeks' disability and the time lost aggregated 10,000 days and figured on a wage basis of $3 a day, the loss to the employes was $30,000, although the loss to the employers was much greater, on account of the reduction in output.

The problem of accident prevention was carefully considered by the committee and in the line of eye protection, all types of goggles were obtained and tried in the shops of members. It is not a question of whether the goggles meet the approval of the manager or foreman, but they must meet with the approval of the workman who is to wear them. One type particularly disliked rested heavily on the nose, although another was so constructed that the bridge did not contact with the nose and the lenses practically rested on the cheek bones. It is probable that one type of goggles will be standardized and will be recommended to the members for use. The colors of lenses best adapted for such work as welding, cutting metals, etc., is being investigated and one type that merits consideration is bifocal.

Leggings for Molders

By far the largest number of accidents in foundries are caused by splashing metal and the congress type of shoe is recommended for adoption. A special shoe was made according to specifications drawn up by the committee, the uppers of which are approximately 2 inches higher than those of an ordinary shoe to insure ample protection for the legs, and the sole does not extend beyond the upper, thereby eliminating the possibility of the lodgment of metal on this extension. The gore is made of the best material obtainable to always insure a tight fit around the legs and this type of shoe can be purchased at approximately $2 per pair in lots of 300 pairs.

Leggings to be worn by molders when pouring-off, is another safeguard that has been investigated and which is recommended by the committee. One type of legging that is being used in the plant of Wm. Sellers & Co., Philadelphia, has three clasps and a strap at the bottom, but this was not recommended owing to the fact that it is difficult to remove in case of accident and molten metal might lodge around the clasps. The committee is experimenting with a cheap legging made of canvas with metal clips at the top and bottom which will insure a snug fit around the legs at all times and they possess the further advantage of easy removal in case of accident. Danger signs also have been recommended and funds have been provided for an assistant to the committee who will investigate the plants of members of the association, with a view to recommending safety devices that should be installed.

Savings Bank Insurance

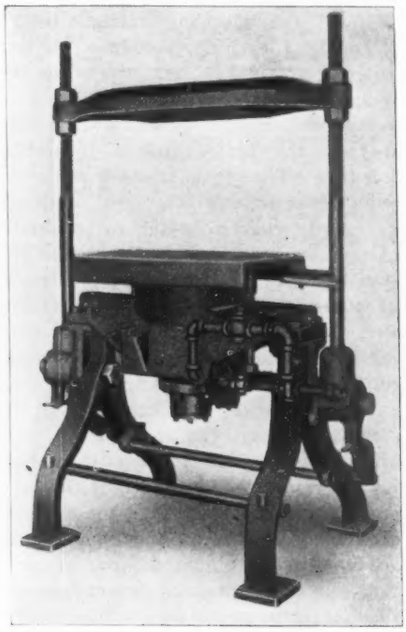
Considerable interest in the discussion of the problem of how to help their employes to obtain insurance at a minimum of cost, was manifested by the foundrymen in attendance at the monthly meeting of the New England Foundrymen's Association, held at the Exchange club, Boston, Wednesday evening, Nov. 12. The discussion of this subject was preceded by an address on "Savings Bank Life Insurance", by H. W. Kimball, secretary of the Massachusetts Insurance League. The speaker told what is being done in this line as a result of a recently enacted state law, enabling certain savings banks to write life insurance. Six banks of the state have been empowered to issue insurance policies and other banks are acting as agents for these specified institutions. Moreover, nearly 200 different manufacturers, in behalf of their employes, are serving as agents of the different banks in getting insurance for their men. The object of the law is to give the workmen the benefit of as low a rate on insurance as is possible to be obtained from regular companies by those of larger means. The measure so far has worked quite successfully. Some criticism of the law was made in the discussion, because it provides that foundry employes are included in the class which is required to take out insurance on the monthly basis.

The Bigas Co., Elmira, N. Y., has been incorporated with $10,000 capital to engage in the manufacture of a flux for treating copper, brass, bronze, aluminum and non-ferrous alloys. The executive offices are located at Elmira, N. Y., and the laboratory and manufacturing plant are at Bridgeport, Conn. Bert Stiles is president of the company.

The Mumford Molding Machine Co., 30 Church street, New York City, represented in the west by the Vulcan Engineering Sales Co., Chicago, has the exclusive sale of its line of molding machines throughout the eastern territory.

A Jolt-Ramming Squeezer

A combination jolt-ramming squeezer molding machine, particularly adapted to molding deep work, is being built by the Davenport Machine & Foundry Co., Davenport, Ia. The mold is rammed on the jolting table, but in place of butting-off the sand by hand the mold is finished by the squeezing operation. In addition to being adapted to making molds, this machine can be used to advantage for making cores. It also can be employed as a plain squeezer when it is not desired to ram the mold by jolting. As shown in the accompanying illustration, the machine is equipped with two cylinders, one for effecting the jolting operation and the other for the squeezing operation. The jolt-



DAVENPORT COMBINED JOLT-RAMMING AND SQUEEZER MOLDING MACHINE

ramming piston is 3 inches in diameter and the squeezer piston 10 inches in diameter; the table is 19 x 24 inches and the distance between the strain rods is 32 inches. When ramming a mold, the flask is set on the table, filled with sand and air is admitted to the jolting cylinder for ramming. After the completion of the jolting operation, air is admitted to the squeezing cylinder and the table with the mold is elevated until it contacts with the squeezer head, thereby finishing the mold. The machine is equipped with an air gage to permit of squeezing the mold to any predetermined pressure. This machine is built in both stationary and portable types.

For temporary repairs a furnace lining of a refractory nature may be made from asbestos and water glass. It can be used for patching cracks, as it does not crumble as readily as other similar compositions made from clay. The mixture consists of fine asbestos, 40 pounds, and water glass, 60 pounds. Water glass is silicate of soda and is mixed with the asbestos with a sufficient amount of water to form a pasty mass that readily can be worked.

Book Review

Hendricks' Commercial Register, 1,635 pages, published by the C. E. Hendricks Co., 74 Lafayette street, New York City, and furnished by THE FOUNDRY, Cleveland, for $10 net.

The twenty-second annual revised edition of Hendricks' Commercial Register contains 1,635 pages, an addition of 89 pages as compared with the previous number. The register covers completely the architectural, engineering, electrical, mechanical, mining, manufacturing and kindred trades and professions. The index requires 138 pages and there are approximately 400 classifications on each page, or a total of about 55,000 in the work. The register is so arranged that the book can be used either for purchasing or mailing purposes, the manufacturers first being classified under a general head and then subdivided under as many classifications as are necessary to represent their product. The trade names of all articles classified, to a large extent, are included.

A Remarkable Cupola Record

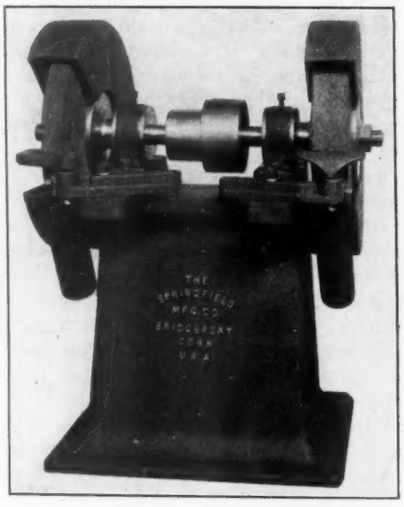
In the gray iron foundry of the Gray & Dudley Hardware Co., Nashville, Tenn., iron still is being melted in a cupola with the same lining that was put in the furnace on June 2, 1912. To Oct. 10 the cupola was operated 423 days and the total amount aggregated 11,239 tons. During this period no brick have been replaced and the lining only has been daubed from day to day. The cupola melts from 14½ to 16 tons per hour and the melting ratio has averaged from 8.1 to 8.4 pounds of iron to 1 pound of coke. The blast pressure averages from 0.8 to 0.9 pounds per square inch. The brick is laid approximately ¾ inch from the shell of the furnace and the intervening space is filled with sand. Neither mortar nor fire clay are used for laying the brick, which are merely faced with a thin mixture of fine sand and fire clay.

A Ball-Bearing Dry Grinder

A new type of ball-bearing dry grinder, especially adapted to foundry use, has been added to the line of machinery manufactured by the Springfield Mfg. Co., Bridgeport, Conn. It is built in two sizes, for wheels up to 2 x 16 inches, and 4 x 24 inches.

The outer bearing case is designed especially for grinder service, being provided with two felt packing rings on each side of the bearing. In addition, the end shells fit closely to the shaft.

The machines can be furnished with hoods, as shown in the accompanying illustration, which enclose the entire wheel with the exception of a space sufficient for grinding. The end covers of the hood can be removed,



BALL-BEARING DRY GRINDER FOR CARRYING 4 x 24-INCH WHEELS

thus facilitating the replacing or changing of wheels.

Mixture for Gasoline Engine Cylinders

By W. J. Keep

Question.—We manufacture agricultural implement castings and use a mixture of a Scotch and Middlesbrough iron with agricultural scrap. We intend to manufacture gasoline engines, however, and would like to know whether the same mixture would be satisfactory. Our test bars break at an average of 440 pounds, using a ½-inch square bar 12 inches between centers. Is this a good test for agricultural work? We also would like to know whether there is a satisfactory process for skimming iron while pouring it into a mold other than the hand skimmers now employed.

Answer.—A mixture for good cylin-

der castings should contain about 2.50 per cent silicon, 1 per cent phosphorus, sulphur not over 0.50 per cent, and manganese, 0.50 per cent. A good grade of coke should be used, as well as a sufficient amount of Scotch iron containing about 10 per cent silicon to increase the silicon in the mixture to 2.50 per cent. The problem is not one of strength, as much as it is one of close grain so that the cylinders will not leak. With test bars breaking at an average of 440 pounds, you have a very strong iron and if you can get 400 pounds with close grain you will do well.

With reference to skimming the metal, you can pour the iron from the bottom of the ladle, using a bottom-pour ladle such as is employed in steel foundries, or you can attach a skimmer close to the pouring lip. Throw a small amount of dry sand over the surface of the iron in the ladle after the kish is skimmed off. This will catch the slag as it rises while pouring.

A Compilation of Electro-Plating Hints

(*Continued from page* 546)

usually the men who employ too few anodes in the bath. It is practically impossible to have too much nickel anode surface when the quantity of anodes is kept barely sufficient to produce a deposit in the ordinary time and of good quality. The nickel is not given off as fast as it is deposited and as a result the solution is impoverished of metal and free sulphuric acid remains. The normal balance of the bath is thus disturbed and various irregularities occur which are perplexing, to say the least. Sparing the nickel anode is in no manner economical, but on the contrary, it is an expensive method. From a theoretical standpoint an anode surface equal to the cathode surface would be sufficient, if there were no secondary reactions. In gold, silver and a few other baths, this proportion is practical, but with nickel in particular, the anode surface must be in excess of the cathode surface to insure long life to the bath, peace of mind to the plater and satisfaction to the public who buy the finished product.

If the nickel deposit shows a tendency to corrode or turn yellow, the cause is usually the employment of a high current density which increases the amount of iron deposited. With the nickel solutions worked at from 4½ to 5 Baume, with a voltage of about 1½ to 1¾, the deposits are less liable to turn yellow. The nickel solution should be kept slightly acid. Agitated nickel solutions yield a greater percentage of iron because of the higher current density required. From 1 to 2 per cent of iron is not uncommon in nickel deposits from agitated solutions.

Continuous Melting

By W. J. Keep

Question.—What weight charges do you recommend for a 22-inch cupola operated continuously for eight hours with a melt of 24 tons during this period?

Answer.—You will have to learn how to operate continuously largely by experience. It involves slagging off the ash continuously and you will be obliged to use more coke than in ordinary melting. For a 22-inch cupola three tons of metal during the first hour can be considered fast melting and to continue this for eight hours seems to be almost impossible of accomplishment. The silicon and phosphorus should be comparatively high and your coke should be low in sulphur. The limestone should be broken fine and its content of lime should be approximately 80 per cent.

A New Aluminum Alloy

William A. McAdams, Bay Shore, N. Y., recently was granted a patent on an aluminum alloy, which it is claimed, is well adapted for casting, is resonant and has a permanent luster. The alloy consists of the following: Aluminum, 60 parts; zinc, 20 parts; silver, 16½ parts, and copper, 5 parts.

THE MEN IN THE FOUNDRY TRADE

Where They Are and What They Are Doing

George Veillard, formerly affiliated with the Roman Bronze Co., Brooklynn, has been appointed manager of Joseph Reinbold & Co., Newark, N. J., manufacturers of bronze, silver and gold castings.

Hugh McPhee, formerly affiliated with the Aluminum Bronze Foundry, Tarrytown, N. Y., has been appointed superintendent of the brass foundry operated by the Kelly & Jones Co., Greensburg, Pa.

W. L. Abate, formerly superintendent of the Nathan Mfg. Co., New York, has been appointed Detroit representative of the Nassau Smelting & Refining Works, New York City.

Arthur Leidig, director of J. W. Jackman & Co., Ltd., London and Manchester, Eng., is now in this country visiting manufacturers of foundry supplies and equipment, many of whom are represented abroad by his company. Mr. Leidig attended the exhibition at Chicago.

W. M. Corse, works manager of the Lumen Bearing Co., Buffalo, has resigned to become general manager of the Empire Smelting Co., Depew, N. Y. He assumes this position on Jan. 1. H. P. Parrock, sales manager of the Lumen company, will assume Mr. Corse's duties as superintendent, combining the two offices. Mr. Corse is secretary of the American Institute of Metals.

Samuel B. Myers has disposed of his interest in the Gerline-Myers Brass Foundry Co., Kalamazoo, Mich., and has resigned as secretary and treasurer. He has been succeeded by Seymour H. Franklin and the officers at present are as follows: Samuel Franklin, president; Otto Gerline, vice president and manager, and Seymour H. Franklin, secretary and treasurer. The firm name has been changed to the Gerline Brass Foundry Co.

Fred T. Hipkins has resigned as foreman of the foundry of the J. & W. Jolly Co., Holyoke, Mass., to engage in the manufacture of match-plates and machine molding specialties. Mr. Hipkins is one of the organizers of the United States Match Plate Co., with a plant at 519 Main street. He has been elected president and general manager and Charles Manos is secretary and treasurer. In addition to manufacturing match-plates and molding machine specialties, the company also will produce brass and aluminum castings.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The National Foundry Co., Milwaukee, has been incorporated for $10,000 by John Flatz, John G. Harwig and Leo C. Flatz.

The foundry of Frank Starry & Sons, Cedar Rapids, Ia., was burned recently with a loss of $10,000.

Walter N. Taylor and Joseph E. Slattery have purchased the foundry of Ralph B. Francis, Palmer, Mass.

The Flood City Mfg. Co., Johnstown, Pa., has completed the erection of a new foundry near Moxham, a suburb of Johnstown.

The Uxbridge Foundry Co., Ltd., has been incorporated at Toronto, Canada, for $40,000 by William S. Thomas, William J. Mitchell and Robert J. Christie.

The Wing & Myers Foundry Co. has been incorporated at Columbus, O., for $20,000 by J. E. Snyder, E. L. Snyder, C. H. Wing, N. A. Beach and S. C. Myers.

The Bowler Foundry Co., Cleveland, has placed a contract for enlarging the crane runway. A portion of the present building is being torn down.

The Gould Balance Valve Co., Kellogg, Ia., manufacturer of ensilage cutters, balance valves and disc sharpeners, has abandoned its project of building a foundry this year.

The Marion Machine & Foundry Co., Marion, Ind., has purchased the plant of the Central Machine & Foundry Co. Improvements include a new cupola.

The Enterprise Iron & Foundry Co., Fort Worth, Texas, has been incorporated for $15,000 by W. H. Horrell, J. A. Horrell and J. Horrell Jr., all of Fort Worth.

The Conway-McLeod Co., Detroit, has increased its capital from $15,000 to $50 000 and will enlarge its business, which consists largely of a foundry for producing plumbing and heating goods.

The Racine Foundry Co., Racine, Wis., which enlarged its foundry early this year, will soon occupy its new pattern shop building on Washington avenue. The company specializes in automobile engine work.

The Erie Nut & Bolt Co., Erie, Pa., now being organized, probably will occupy the foundry and machine plant of the Morse Iron Works, which is being vacated by the latter retiring from business.

The Wisconsin Aluminum Foundry Co., Manitowoc, Wis., will begin operating its new plant shortly. The new foundry is fireproof and about three times the size of the old one. The equipment will be practically new throughout.

The Turner Mfg. Co., Port Washington, Wis., maker of gasoline engines, has started to manufacture small concrete and cement mixing machinery operated by gasoline engines and adapted for farm use. The company formerly was the Western Malleable & Gray Iron Foundry Co.

The Wheeling Mold & Foundry Co., Wheeling, W. Va., has completed a number of improvements, including a covered crane runway 700 feet long and 60 feet wide, equipped with two Alliance cranes, each of 30 tons capacity. A new cleaning shop and an annealing furnace department have been erected at one end of the runway. A second covered crane runway, 350 feet long and 60 feet wide, has been installed at the rear of the main foundry, equipped with a 30-ton crane and smaller cranes equipped with lifting magnets and grab buckets for handling pig iron, scrap, etc. A new roll foundry and erecting shop, 60 x 300 feet, also have been completed.

New Construction

The plant of the Coosa Pipe & Foundry Co., Birmingham, Ala., was closed recently for extensive improvements.

The Wesson Foundry Co., Dallas, Texas, will rebuild its foundry recently damaged by fire. Equipment costing $3,000 will be installed.

The Homer Motors Co., Los Angeles, Cal., will erect shops for the manufacture of tractor, motor trucks. A foundry is included in the plan.

The Columbia Steel Co., Pittsburg, Cal., manufacturer of converter and open-hearth steel castings, recently completed a three-story pattern storage, 180 feet long and 60 feet wide.

The Hyde Park, Pa., Foundry & Machine Co. is adding an addition to its plant, 60 x 110 feet. A new office building also will be erected.

The J. Davenport Co., Stamford, Conn., manufacturer of piano plates, is having plans prepared for the erection of a large addition to its foundry. Ground will be broken shortly after the first of the year.

The American Brass Foundry Co., Milwaukee, has increased its capital from $5,000 to $12,000 to purchase additional equipment. The company will make a specialty of aluminum castings and bearing bronzes for motor cycles.

N. F. Kendall, Grafton, W. Va., has prepared plans and specifications for a foundry which he proposes to erect at that place for a company now being organized. The building will be of steel and brick, estimated to cost $40,000.

The Sanitary Stove Mfg. Co., Benton, Ill., is erecting an addition to its foundry and is in the market for an extensive line of foundry equipment. The company would like to receive catalogs from various manufacturers of foundry machinery.

The Iron & Steel Products Co., Tulsa, Okla., recently incorporated for $100,000, has taken over the Sand Springs Rolling Mills. The rolling mill will be completed and a steel and gray iron foundry erected. Max K. Weigle, master mechanic of the Oklahoma Iron Works, is the principal incorporator.

The Henry Fire Apparatus Co., Tampa, Fla., recently incorporated for $2,000,000, has taken bids for three buildings, 85 x 200 feet, estimated to cost $75,000. Foundry equipment and pattern and lathe machinery will be installed. Machinery bids will be asked later, to be opened March 1.

The Electric Steel Foundry Co., Portland, Ore., is erecting a 60 x 80-foot foundry at Twenty-fourth and York streets and expects to operate about Jan. 1. This company succeeded the Portland Bronze & Crucible Steel Foundry. A new electric melting furnace will be installed. Leonard Schad is president; C. F. Swigert, vice president and George F. Schott, secretary.

The machine shop and foundry at Chippewa Falls, Wis., formerly operated by F. G. & C. A. Stanley, has been purchased from the Midland Lumber Co. by William Smiley and son William Smiley Jr., of Minneapolis, who are rebuilding the shops and about Jan. 1 intend to engage in the production of gasoline tractors and small machinery. The foundry already is in operation.

NEW TRADE PUBLICATIONS

SHAFTING.—A 32-page catalog and price list covering its extensive line of steel shafting recently has been issued by Bliss & Laughlin, Inc., Harvey, Ill.

ABRASIVE WHEELS.—A loose-leaf catalog, issued by the Scranton Whetstone & Abrasive Wheel Co., Scranton, Pa., devoted to corundum and emery wheels, illustrates and describes the various shapes manufactured by this company. These wheels are adapted to all kinds of grinding and numerous special shapes are shown. This company also manufactures oil stones, water stones, etc., for sharpening edge tools.

FOUNDRY EQUIPMENT AND SUPPLIES.—In a comprehensive 176-page catalog, the Central Foundry Supply Co., Columbus, illustrates and describes its extensive line of equipment and supplies for iron, steel, malleable and brass foundry use. Practically every machine necessary to equip the modern shop is shown, from the cupola to the casting department, and the line of supplies includes everything from chaplets to molders' tools, etc. The catalog concludes with an index which will facilitate references to the various lines included in this work.

CENTRIFUGAL PUMPS. — The A. S. Cameron Steam Pump Works, 11 Broadway, New York City, has issued a bulletin illustrating and describing its new line of double suction volute centrifugal pumps. In addition, the bulletin contains considerable detailed information regarding the construction of this pump, which is built with an enclosed impeller, a horizontally split casing providing ready access to all interior parts. An efficiency chart, figures on pressures, etc., which should prove of value to engineers, also are contained in this bulletin.

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